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ICHITA-2011 TRANSACTIONS

The First International Conference on Health Information Technology Advancement

Kalamazoo, Michigan, October 28, 2011

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Western Michigan University

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Volume 1, No. 1

Hosted by

**The Center for Health Information Technology Advancement, WMU
Relationship-Centered Care Network of Southwest Michigan**

ICHITA-2011

Kalamazoo, Michigan 2011

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**TRANSACTIONS OF THE INTERNATIONAL CONFERENCE ON HEALTH
INFORMATION TECHNOLOGY ADVANCEMENT, VOL. 1, NO. 1
October 28, 2011**

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Conference Co-Chairs' Message

Bernard Han, Ph.D. and Sharie Falan, Ph.D., RN, BC, CPHIMS

Health care has been in crisis for more than a half of a century. The passage of the *American Recovery and Reinvestment Act* (ARRA) by the U.S. Congress on February 17, 2009 and the creation and adoption of the Health Care Reform Bill by the President Obama on March 23, 2010 are simply the reflection of the urgency for health care reform. Ushered in with health care reform is the use of technology to create processes whereby shared understanding through information exchange occurs. In response to the health care mandates and in order to build a responsive community, the constituents of Western Michigan University created a university-wide center, the *Center for Health Information Technology Advancement* (**WMU-CHITA**) on April 15, 2010. The establishment of WMU-CHITA is to promote productive Health Information Technology research, education, and services for the delivery of best health care with quality, safety, security, and sustainability. To fulfill this goal, with joint interests between *Relationship-Centered Care Network of Southwest Michigan* (**RCCSWMI**) and WMU-CHITA, a planning committee was formed in March 2011 to initiate an *International Conference on Health Information Technology Advancement* (**ICHITA**). The conference planning team was commissioned to pool talents from the community, the United States, and overseas to pursue the betterment of health care via relationship-centered care and health information technology. While the lead-time for this event was less than six months, the importance of the conference was well recognized by our educational peers, both domestic and international, and the health care and information technology stakeholders in the community. We have not only successfully recruited known scholars and practitioners as keynotes, speakers, and workshop leaders for ICHITA, but also received research papers and position papers that are to be presented at ICHITA and published in this *Transactions of ICHITA-2011*, a refereed periodical that is produced in both paper format and digital form (DVD).

An array of research subjects have been covered by accepted research papers and position papers. For a quick overview, they are divided into five major tracks: *Health Care Practice*, *Health care Infrastructure and Implementation*, *Security and Privacy*, *Relationship-Centered Health Care*, and *Health Information Technology & Education*. A brief highlight on the contributors is given below.

Health Care Practice. There are four papers in this track. DeMello and Deshpande focuses on the impacts of factors that affect the use of information technologies (IT) in clinical practice. Their findings show that specific strategies are needed to increase the use of IT in health care. Ravotas addresses the issue that the use of institutionally designed documentation may impact the practice of health care. Krishnaswamy introduces a model to explain how electronic payment systems will improve the efficiency of health care services. Leidig et al. illustrates how computer modeling and simulation can be used to assist governments in setting the health care policy.

Health care Infrastructure and Implementation. Three papers are accepted in this track. First, Targowski discusses the key issues involved in health information exchange and then proposes a top-down national health information network in support of the implementation of electronic health records (EHR) in the United States. Dobrzykowski shares findings from an extensive study of

the structural constraints of Acute Care Hospitals and analysis of the adoption of EHR by different types of hospitals. Razi et al. examine the challenges before and after the implementation of EHR.

Security and Privacy. There are three presentations in this track. Lehrfeld et al. address the security and privacy issues associated with mobile (wireless) devices and discuss how to secure personal data when these devices are used in the health care environment. Salih and Lilien point out privacy threats commonly occur to electronic medical records (EMR) and/or EHR, and a specific bundle scheme is proposed to protect sensitive data via the use of a virtual machine. Chen and Lee give an extensive review of security and privacy issues in health care information systems.

Relationship-Centered Health Care. This track is composed of three studies. Dohan and Tan focus on the barriers and facilitators of relationships among clinicians and present a framework that will sustain practice audit for continuous health care quality improvement. Manning-Walsh gives a review on relationship-centered care and proposed a model to explore issues on how health information technology can affect relationship-centered care. Rea et al. present a social networking adoption matrix and demonstrate how it can be applied to the development of an expert system. The system is to assist health care organizations in selecting a proper social networking technology to enhance a hospital's relationship management with patients.

Health Information Technology & Education. Four papers have been selected in this track. Dobrzykowski et al. present the curriculum development of health care for the graduate programs at Eastern Michigan University. Falan and Han present a new approach to the design of an undergraduate health informatics and information management curriculum across multiple disciplines. Rienzo discusses how the disruptive innovation theory could be used together with HIT to salvage the health care industry. Tremblay highlights how to leverage HIT to enhance the efficiency of health care efficiency and to create strategic impacts on the health care industry.

As conference co-chairs, there are many people deserving our thanks. First, our thanks go out to all of the sponsors who provided support to ICHITA. Due to the space limit, the names of sponsors are not listed individually. However, it cannot be overstated that their generous support made this conference possible. Second, the contributors who submitted papers and reviewers who provided timely comments have significantly substantiated the quality, the value, and the contents of this publication. We deeply appreciate your efforts. Of course, among them, the Transactions Editor, Dr. Huei Lee, deserves our special thanks. Dr. Lee has tirelessly taken care of the paper submissions, blind reviews, editing, and compilation of all papers in the Transactions. Without him, the Transactions would never be published in time.

All program co-directors and members on the ICHITA planning committee are also deserving of our special thanks for their hard work and painstaking promotion of ICHITA-2011. It is our plan that ICHITA will be held every other year, and ICHITA-2011 sets the landmark for an integrative effort in pursuing the excellence of health care through health information technologies.

Lastly, definitely not the least, Western Michigan University and the administration of WMU shall receive our sincere thanks for their strong support of WMU-CHITA. Let us move on towards better health care through innovative use of Information Technologies.

Bernard Han & Sharie Falan
Conference Co-Chairs, ICHITA-2011

Message from the Transactions Editor

Huei Lee, Ph.D.

It is my pleasure to present the *Transactions of the International Conference on Health Information Technology Advancement*, which is related to the ICHITA-2011 held in the Western Michigan University, Kalamazoo, Michigan on October 28, 2011. Firstly, I would like to express my appreciation to Bernard Han, Program Director of the Center for HIT Advancement, and Sharie Falan, the Associate Director of the Center for HIT Advancement, for their frequent help and their outstanding leadership. Through their help, the editorial process became easier and smoother.

This was the first year to publish the Conference Transactions. As the transactions editor, I personally believe that we cannot attract the attendance of faculty from AACSB or accredited universities without publishing refereed conference transactions or proceedings. Due to budget cutbacks, many universities require their faculty to have their paper published in the refereed publications in order to gain travel funds. Attending an academic/professional conference often means a chance for junior faculty to gain useful knowledge in both teaching and research. The purpose of this conference is not only to discuss the information systems of health care applications, but also to discuss academic curriculum trends and critical issues related to health care information systems. This year we received a moderate amount of submission. This volume contains about twelve refereed papers and four position papers, developed by more than thirty authors and co-authors. These papers have been gone through a rigorous double-blind review process. The Transactions publishes hard copy, CD, and online edition. The online edition provides a list of presentation abstracts and PowerPoint slides as Appendix. Secondly, I want to thank the authors, presenters, and reviewers for their persistent hard work for these papers/reviews for the Transactions of the ICHITA-2011 conference. I know that it was a lot of hard work, but it was well worth.

Finally, I would like to sincerely thank everyone again for their participation in the ICHITA-2011. It has been an honor and a privilege to serve as the transactions editor. Without your help and support, the Transactions would not have been possible. In addition, the committee will greatly appreciate it if you can provide them with ideas and issues so that they can improve the quality of the Transactions in the future. We wish you enjoy the conference in Western Michigan University and look forward to seeing you again in future ICHITA conferences.

Western Michigan University Center for Health Information Technology Advancement (CHITA)

Our Vision:

To be the leading institute that provides the most productive Health Information Technology research, education, and services for the delivery of best health care with quality, safety, security, and sustainability.

Our Mission:

To integrate our talented faculty and students to work with our community, state, national, and international stakeholders in conducting synergistic, interdisciplinary, and innovative research, training, and services to provide most efficient and effective health care globally.



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Factors Impacting Use of Information Technology by Physicians in Private Practice

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Abstract: This research examines the impact of various factors on the use of IT in clinical practice, prescriptions, and patient information. This was done using a national sample of 3425 physicians who worked in a solo or group practice in the United States. Besides the extent of use of electronic medical records by physicians and number of physicians in practice, none of the other factors consistently impacted the use of IT in clinical practice, prescriptions, and patient information, respectively. The results of this study highlight the need to develop specific strategies to increase the use of information technology in healthcare.

INTRODUCTION

Health information technology (HIT) has been identified as a necessary tool in the battle to improve the efficiency, quality and delivery of health care in the United States (Payton, Pare, LeRouge, & Reddy, 2011). In spite of the explosion of applications of information technology at work in various sectors of the US economy, it is rather surprising that healthcare remains one of the few industries which still rely heavily on paper records (Gates & Roeder, 2011). The federal government through the Office of the National Coordinator for Health Information Technology (ONC) has been actively pushing for the rapid transition of healthcare information and communication into the 21st century. The potential for quality, accuracy, and cost improvements is tremendous and preliminary studies show that many benefits like improvements in accuracy, quality, and can accrue to different stakeholders like institutions, patients, and providers (Blumenthal, 2010; Goldzweig, Towfigh, Maglione, & Shekelle, 2009).

Unfortunately, in spite of the overwhelming evidence regarding the positive effects of HIT innovations like electronic health records (EHR) on the quality and efficiency of health care, there is still considerable skepticism about adopting the technology among health care providers, especially those in private practice settings (Buntin, Burke, Hoaglin, & Blumenthal, 2011). In fact, a recent report indicated that although the USA spends around \$2 trillion per year on healthcare (16% of GDP, \$6697 per capita) only about 15% of its physicians use EHRs to manage patients' health information. This compares with a roughly 29% utilization rate of physicians in the European Union (Maharajah and McIntyre, 2010). Since 2009, the Obama Administration has made an unprecedented attempt to promote the adoption of EHRs and spur the development of further innovations in health care delivery systems. This includes passage of the Health Information Technology for Economic and Clinical Health (HITECH) Act into law in 2009 (as part of the American Recovery and Reinvestment Act), committing

approximately \$27 billion as incentive payments to hospitals and care providers, establishing various programs and centers to promote, coordinate, and supervise the development and implementation of innovative payment, health care delivery models, and health information systems in the United States (Buntin et al., (2011).

Preliminary reviews on the effects of health information technology innovations have revealed positive benefits, especially for larger organizations that were early adopters of the technology (DesRoches, Campbell, Rao, Donelan, Ferris, & Jha, 2008; Jha, DesRoches, Campbell, Donelan, Rao, & Ferris, 2009). But, there were significant negative reactions from health care providers regarding the start-up costs and loss of patient contact time that would result as a consequence of adopting the technology (Bates, 2005; Georgiou, Westbrook, Braithwaite, Idema, & Ray, 2007; Georgiou & Westbrook, 2009). These kinds of reactions have resulted in a significantly slower than anticipated rate of adoption of the Health IT systems by some types of health care providers.

LITERATURE REVIEW

A recent review of 154 studies on the effect of health information technology on various desired outcomes (e.g., including quality, efficiency, and provider satisfaction) found that 62% of the studies concluded that HIT was associated with improvements in one or more aspects of care, with no aspects worse off. In addition, 92% (142 out of 154) of the studies were either positive or the authors drew a positive conclusion overall but pointed out at least 1 negative aspect of HIT (Buntin *et al.*, 2011). The negative findings included issues such as: longer times taken for e-prescribing versus hand-written prescriptions (Hollingworth, Devine, Hansen, Lawless, Comstock, & Wilson-Norton, 2007); lack of proper leadership and implementation of health IT in a small rural hospital leading to an increase in patient care, medication, and procedure errors (Spetz & Keane, 2009); inhibition of provider-patient interaction during ward rounds caused by use of EHR rather than paper charts (Morrison, Jones, Blackwell, & Vuylsteke, 2008); work-flow problems at a pathology lab after electronic receipts of orders (Georgiou et al., 2007, Georgiou and Westbrook, 2009); unsuccessful implementation of HIT systems due to variability in computer literacy and information systems (Trivedi, Daly, Kern, Grannemann, & Sunderajan, 2009); impairment of nurse-physician medication collaboration caused by computerized provider order entry (Pirnejad, Niazkhani, van der Sijs, Berg, & Bal, 2008); and over-reporting of cases due to implementation of an e-reporting system (Centers for Disease Control and Prevention, 2008). Most of the negative findings point out to the need for a better assessment of the human element in HIT implementation. Specifically, there is a need for studies that document the challenging aspects of implementing health IT more specifically and how these challenges might be addressed (Buntin et al. 2011).

Most of the HIT research to date has focused on the effectiveness and utilization of EHR by health-care providers (Shea, & Hripcsak, 2010). Although recent reports indicate that the availability and use of EHR is increasing in the United States, the rate of increase is much slower than that required for reaching the goal set by the Obama Administration of a universal adoption and utilization rate by 2014. In particular, providers serving Hispanic or Latino patients who are uninsured or rely on Medicaid and primary care providers in private solo or small group practices have the lowest adoption rates (under 6%) compared with an adoption rate of 38.3% for providers in HMOs, faculty practice plans, and urgent care centers. In addition, hospital outpatient departments and community health centers exhibit much higher adoption rates than solo and partner practices. (Gibbons, 2011).

Besides slow adoption rates of EHRs, a number of other problems exist in the overall implementation of HIT in the United States. Some of the major barriers identified in the literature are: the preponderance of proprietary applications which typically support fragmentation in patient, people and process data and workflow aggregation; the perception that electronic health records (EHRs) are mainly to be used for internal organizational purposes with limited connections to external constituents, such as patients, external providers and public health agencies and researchers; widespread concerns regarding patient privacy tend to hinder the availability of content for public health and research initiatives; and the largely financial emphasis of the fee-for-service health delivery model that has prevented health care IT from focusing primarily on clinical functions (Payton et al. 2011).

For the health information technology systems and innovations to have widespread success it is imperative that there be “buy in” at all levels and across all types of health care providers. This in turn means that there is a need for understanding the level of availability, acceptance, barriers, and reasons why some physicians are reluctant to embrace the technology. This understanding will enable us to develop and implement appropriate systems and policies to minimize the barriers and negative reactions from health care providers. This paper is an attempt in that direction.

METHODS

Sample

The data for this study came from the Center for Studying Health System Change’s (HSC) 2008 Health Tracking Physician Survey (HTPS). HSC is a Washington D.C based organization that aims to provide unbiased and dependable health care related information to policy makers. The 2008 HTPS replaced the four (1996-97, 1998-99, 2000-01 and 2004-05) Community Tracking Study (CTS) physician surveys conducted by HSC. While the CTS consisted of telephone interviews of physicians in 60 randomly selected U.S. communities, the 2008 HTPS was conducted by mail and used a national sample of physicians. The website <http://www.icpsr.umich.edu/icpsrweb/HMCA/studies/27202> has detailed information on the 2008 HTPS.

The 2008 HTPS dataset used in this study consists of 4720 completed surveys based on a list of physicians provided by the American Medical Association. These surveys were conducted between February 2008 and October 2008. Not included in the survey were residents, fellows, federal employees, foreign medical school graduates who are temporarily licensed to practice in the United States and specialists whose primary focus was not direct patient care. The 2008 HTPS Methodology Report at <http://www.hschange.com/CONTENT/1085/1085.pdf> has comprehensive information on the methodology used to collect the data. It provides detailed information on issues like the instrument design, target population, and stratification process. Only those physicians who worked most of their time in a solo or group practice were included in our study. Thus, those physicians who worked mostly for HMO’s, hospitals, medical schools, or other classifications were not included in this study. Therefore of the 4,720 completed surveys in the dataset, we only considered 3425 physicians who worked in a solo or group practice for this study.

Dependent Variable

Use of IT in clinical practice, use of IT in prescriptions, and use of IT in patient information were the three dependent variables in this study. These three constructs were measured on the following scale: 3=IT available and used, 2=IT available and not used, 1=IT not available. Use of IT in clinical practice was measured using six items. These items covered use of IT for obtaining recommended guidelines, decision support for diagnostic and treatment recommendations, generating reminders for clinicians about preventive services, generating reminders for other needed patient follow-up, generating reminders to patients about preventive services, and emailing patients about clinical issues. Use of IT in prescriptions was measured using four items that examined use of IT to obtain information on potential patient drug interactions, obtain information on formularies, write prescriptions, and transmit prescriptions to pharmacy. Use of IT in patient information was measured using six items. These items examined the use of IT to access patient notes, order diagnostic tests, view results of diagnostic tests, exchange clinical data and images with other physicians, exchange clinical data and images with hospitals and laboratories, and access information on patients’ preferred language. Detailed information on the items that make up our dependent and independent variables are available at <http://www.icpsr.umich.edu/icpsrweb/HMCA/studies/27202>.

Independent Variable

Independent variables used in this study were grouped in four categories. They are practice-related factors, physician-related factors, minority patients, and revenue sources. The scale used to measure the independent variables and their brief descriptions are presented in Table 1. Practice-related factors comprised of three factors:

Competitive situation of practice, number of physicians at practice, and use of electronic medical records. Physician-related factors included demographic variables like age, race/ethnicity, and sex of physicians. It also included factors like annual income of physicians, if primary care physician, and degree of ownership in the practice. Minority patient consisted of three independent variables. They were percent of Hispanic patients, percent of African American patients, and percent of Asian/Pacific Islanders. Revenue sources had three factors. They are percent revenue from Medicare, percent revenue from Medicaid, and if the practice received any financial assistance from health plans and others organizations tied to IT systems adopted by the practice.

Variables	Description	Scale
Competitive situation	Pressure to attract and retain patients	3=very competitive, 2= somewhat competitive, 1= not at all competitive
Number of physicians	Number of physicians in main practice	Categories of 1,2-3, 4-10, 11-50, 51-100, 101 (top coded)
Electronic medical records	Use of electronic medical records	0=all paper, 1=part electronic part paper, all electronic
Age	Age in years	1= >67, 2=67-63, 3=62-58, 4=57-53, 5=52-48, 6=47-43, 7=42-38, 8=<38
Physician race/ethnicity	Race of respondent	1=Hispanic, 2=White, 3=Black, 4=Asian or Pacific Islander, 5=other/mix
Male	Gender of respondent	1=male, 0=female
Income	Categories of Income	6=more than \$300K, 5= \$250,001 to \$300K, 4=\$200,001 to \$250K, 3=\$150,001 to \$200K, 2=\$100,001 to \$150K, 1=less than \$100K
Primary care physician	Primary care physician	1=primary care physicians, 0=specialist
Ownership in practice	Share of ownership in practice	2= full owner, 1=part owner, 0=employee and independent contractor
African American patients	% of African-American patients	Categories of 0%, 1-25%, 26-50%, 51% (top code)
Hispanic patients	% of Hispanic patients	Categories of 0%, 1-25%, 26-50%, 51% (top code)
Asian/Pacific Is patients	% of Asian/Pacific Islander patients	Categories of 0%, 1-25%, 26% (top code)
Medicare revenue	% of practice revenue from Medicare	Categories of 0%, 1-25%, 26-50%, 51-75%, 76%-100%
Medicaid revenue	% of practice revenue from Medicaid	Categories of 0%, 1-25%, 26-50%, 51-75%, 76%-100%
Financial incentive to use IT	Financial incentive received to use IT systems	1=yes, 0=no.

Table 1: Information on Independent Variables

ANALYSIS

Statistical analysis on the data was done using SPSS-17. Cronbach's alpha was calculated for our three dependent variables. In addition, frequency distribution, means and standard deviations were calculated for various items that made up our dependent variables. Zero-order correlations were done to examine the relationships between the dependent and independent variables. In addition, ordinary least square multiple regression analysis was used to examine the effect of each independent variable on our four dependent variables.

RESULTS

Table 2 presents characteristics of the sample. Two out of three respondents were 48 years old or older. Three out of four respondents were male physicians. Over 70% of the respondents were White, non-Hispanic. A majority of the respondents' income was over \$150,001. Table 3 presents the availability and usage of IT for clinical practice, prescription drugs, and patient information by physicians. Among clinical practice related items, IT was available and used by 78% of the physicians to get information on recommended guidelines and 60% of physicians to get decision support. A majority of the other clinical practice related items were not available to the physicians. Among prescription drugs related factors, 65% of the physicians used IT to get information on patient prescription drugs interactions. None of the other prescription drugs related IT factors were available to a majority of physicians. Among patient information related factors, 71% of the physicians used IT to view lab and diagnostic test results. A majority of the other patient information items were not available or not used. Table 4 presents zero-order correlations among the variables. In addition, it presents Cronbach's alpha of constructs on the diagonal in parenthesis. They ranged from .76 to .82 which are considered satisfactory.

Table 5 presents ordinary least square regression analysis results for our dependent variables. Among practice-related factors, number of physicians in practice and use of electronic medical records has a significant positive impact on the three uses of IT. Competitive situation in practice only had a significant impact on use of IT in clinical practice. Among physician-related factors, age impacted use of IT in clinical practice and patient information. On the other hand income and ownership in practice significantly impacted use of IT for patient information. Primary care physician status significantly impacted use of IT in clinical practices and prescription. Physician race or sex had no significant impact on the use of IT. Among minority patients, physicians with Hispanic patients were significantly less likely to use IT for clinical practice or prescription. On the other hand, physicians with Asian or Pacific Islander patients were significantly more likely to use IT for clinical practice or prescription. Those with higher practice revenue from Medicare were less likely to use IT for patient information. On the other hand those with higher practice revenue from Medicaid were more likely to use IT for clinical practice and patient information. Financial incentives to use IT had a significant positive impact on use of IT for prescriptions.

Age (in years)	N	(%)
more than 67	237	(6.9)
67-63	271	(7.9)
62-58	443	(12.9)
57-53	594	(17.3)
52-48	603	(17.6)
47-43	516	(15.1)
42-38	447	(13.1)
less than 38	314	(9.2)
Women	816	(23.8)
Men	2609	(76.2)
Race		
Hispanic	180	(5.3)
White, non-Hispanic	2532	(73.9)
Black/African American	103	(3.0)
Asian or Pacific Islander	486	(14.2)
Other/Mix	41	(1.2)
Not ascertained/Refused	83	(2.4)
Income		
less than \$100,000	463	(13.5)
\$100,001 to \$150,000	737	(21.5)
\$150,001 to \$200,000	636	(18.6)
\$200,001 to \$250,000	466	(13.6)
\$250,001 to \$300,000	368	(10.7)
more than \$300,000	755	(22.0)
Sample size	3425	

Table 2: Characteristics of Sample

Variables	N	IT not available	IT available and not used	used	Mean	SD
IT in clinical practice						
Get info on recommended guideline	3371	19	2.7	78	2.59	.79
Get decision support	3332	35	5	60	2.25	.94
Remind clinician on previous service	3354	66	7	27	1.60	.88
Remind clinician on follow-up	3330	66	6	29	1.63	.90
Remind patients on previous service	3341	68	6	26	1.59	.88
Comm with patients by e-mail	3332	71	13	16	1.45	.76
IT in prescription drugs						
Get info on pat RX interaction	3339	33	3	65	2.32	.93
Get info on formularies	3340	54	8	38	1.84	.94
Write prescriptions	3363	61	5	35	1.75	.94
Transmit RX to pharmacy	3355	65	5	30	1.65	.91
IT in patient information						
Access patient notes	3349	49	2	49	2.00	.99
Order lab, other diagnostic tests	3350	50	4	47	1.97	.98
View lab, diagnostic test result	3350	26	3	71	2.45	.88
Exchange clinical data w/ other phys	3350	59	4	37	1.78	.95
Exchange clinical data w/ hosp & lab	3345	56	5	40	1.84	.96
Access info on pat prefer language	3336	83	6	11	1.28	.65

Table 3: Availability and Usages of IT by Physicians

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Use of IT in clinical practice	(.77)																	
2. IT prescription	0.58	(.76)																
3. IT patient information	0.53	0.61	(.82)															
4. Competitive situation	0.02	-0.03	0.01	1.00														
5. Number of physicians	0.14	0.16	0.24	0.04	1.00													
6. Electronic medical records	0.39	0.54	0.60	-0.04	0.21	1.00												
7. Age	0.04	-0.01	0.02	0.07	0.00	-0.03	1.00											
8. Physician race/ethnicity	0.13	0.11	0.14	-0.06	0.06	0.16	0.07	1.00										
9. Male	-0.03	0.00	0.03	0.06	-0.04	0.01	-0.10	-0.22	1.00									
10. Income	0.00	-0.01	0.13	0.11	0.07	0.07	-0.06	0.05	0.27	1.00								
11. Primary care physician	0.11	0.13	0.02	-0.17	0.05	0.03	0.04	0.08	-0.15	-0.44	1.00							
12. Ownership in practice	-0.07	-0.10	-0.17	0.05	-0.33	-0.14	0.02	-0.24	0.14	-0.02	-0.11	1.00						
13. African American patients	-0.02	-0.02	-0.01	0.06	-0.02	-0.03	0.08	0.02	-0.01	-0.02	-0.05	0.01	1.00					
14. Hispanic patients	-0.04	-0.05	0.00	0.09	0.01	-0.03	-0.02	-0.05	0.03	0.01	-0.01	0.07	0.02	1.00				
15. Asian/Pacific Is patients	0.10	0.05	0.03	0.08	0.03	0.01	0.25	0.03	-0.10	-0.02	0.06	0.03	-0.02	0.19	1.00			
16. Medicare revenue	-0.04	-0.05	0.03	0.04	0.00	-0.03	0.05	-0.07	0.14	0.09	-0.09	0.01	0.04	-0.12	-0.12	1.00		
17. Medicaid revenue	0.05	0.01	0.05	0.00	-0.01	0.01	0.10	0.04	-0.07	-0.10	0.12	-0.05	0.14	0.21	0.01	-0.19	1.00	
18. Fin incentive to use IT	0.07	0.17	0.10	-0.01	0.04	0.13	0.01	0.06	-0.07	-0.03	0.13	-0.07	-0.07	-0.04	0.09	-0.04	0.02	1.00

Listwise N=2424. Correlations above .04 and below -.04 are significant at $p \leq .05$ (two-tailed). Cronbach's alphas are presented on the diagonals in parenthesis.

Table 4: Zero-Order Correlations Among the Variables

Variable	IT clinical practice			IT prescription			IT patient info		
	B	(SE)		B	(SE)		B	(SE)	
Practice-related factors									
Competitive situation of practice	.043	(.016)	*	.002	(.017)		.016	(.015)	
Number of physicians at practice	.062	(.001)	**	.049	(.001)	**	.101	(.000)	**
Electronic medical records	.360	(.014)	**	.501	(.015)	**	.560	(.013)	**
Physician-related factors									
Age	.053	(.006)	**	.011	(.006)		.033	(.006)	*
Physician race/ethnicity	.012	(.014)		-.019	(.015)		.023	(.013)	
Male	-.004	(.028)		.028	(.030)		.020	(.026)	
Income	.027	(.007)		-.016	(.008)		.089	(.007)	**
Primary care physician	.101	(.025)	**	.095	(.027)	**	.031	(.023)	
Ownership in practice	.027	(.016)		.007	(.017)		-.047	(.015)	**
Minority patients									
African American	-.012	(.001)		.004	(.001)		.005	(.001)	
Hispanic	-.051	(.001)	**	-.044	(.001)	**	.010	(.001)	
Asian or Pacific Islander	.085	(.002)	**	.042	(.002)	*	.017	(.002)	
Revenue sources									
Medicare	-.010	(.000)		-.022	(.001)		.051	(.000)	**
Medicaid	.049	(.001)	*	.002	(.001)		.051	(.001)	**
Financial incentives got for IT	.001	(.045)		.097	(.049)	**	.020	(.042)	
F	36.403	**		77.445	**		110.727	**	
Adjusted R square	.173			.306			.391		
N	2543			2601			2560		

**p≤0.01. *p≤0.05

Table 5: Regression Results

DISCUSSION

Much has been written about the financial and nonfinancial benefits of IT in healthcare organizations. Quality of care, managed growth, and improved business performance are some financial benefits identified by physicians. Nonfinancial benefits range from improved documentation and security to freeing up of storage room space to be used as patient examination rooms. One area that has received little attention involves the factors that impact the use of IT by physicians. This is the first nationwide study examining the impact of various practice-related factors, patient-related factors, minority patients, and revenue sources on detailed use of IT by healthcare providers in the areas of clinical practice, prescriptions, and patient information.

Among practice-related factors, the use of electronic medical records had the most significant impact on use of IT in clinical practice, prescriptions, and patient information. Clearly those practices who maintain medical records electronically are more likely to adopt IT for clinical practice, prescriptions, and access and maintain patient information. Unfortunately most medical practices still use paper records (Maharajah, & Macintyre, 2009). While paper records are inexpensive and convenient for physicians to enter data, they require a lot of storage space since many states require medical records to be maintained for a certain period of time. Electronic

records on the other hand require very little storage space, are easy to update and transfer, more legible, but have more security requirements.

The number of physicians in the practice was the other factor that had a significant positive impact on use of IT in clinical practice, prescriptions, and patient information. This suggests that large practices, thanks to their large revenue base, a larger portfolio of services, and a larger support staff are more likely to support the substantial investment and human capabilities needed to manage complex IT systems. Economies of scale also would enable large practices to lower the cost of IT implementation per physician. On the other hand, competitive situation of practice had only a significant impact on the use of IT in clinical practice. This suggests that physicians who work in practices where there is a lot of pressure to attract and retain patients are more likely to invest and adopt IT that make them more effective physicians. These activities include using IT to get recommended guidelines, get decision support, remind clinicians on previous service and follow up.

Among physician-related factors, younger physicians made a more significant use of IT in clinical practice and patient information. Previous research suggests that older physicians are less likely to adopt technology at the workplace (Cook, 2011). Some have suggested that since older physicians are less likely to have grown up using computers as a part of their daily life, they are less likely to use it as a part of their work life (Clayton, Pulver, & Hill, 1993). Implementation of IT at the workplace may impact workflow processes and culture. It is also possible that older physicians are skeptical towards any technology that would change the way they have practiced for years.

Physicians with higher income were significantly more likely to use IT for patient information only. On the other hand, primary care physicians are more likely to use IT for both clinical practice and prescription, but not patient information. It is interesting to note that physician income and primary care physician had a high significant negative correlation ($r=-.44$). This suggests that high income physicians were most likely to be specialists. Our results suggest that primary care physicians and specialists use IT for different purposes. While primary care physicians were more likely to use IT for issues like getting information on recommended guidelines, get decision support, get information on patient interaction, and write prescriptions, specialists (who typically were high income physicians) were more likely to use IT for issues like order and view diagnostic tests, exchange clinical data with labs, hospital and other physicians. Our correlation matrix also indicates that there was a significant negative correlation between physicians with ownership and number of physicians, use of medical records, and primary care physicians respectively. This suggests that physicians with ownership in practice tended to be specialists working in small practices that were less likely to use electronic medical records. Thus it is not surprising that our study found that physicians with ownership in practice were less likely to use IT for patient information.

Our results indicate that medical providers with a large proportion of Hispanic patients are less likely to use IT for clinical practice or prescription. On the other hand, medical providers with large Asian/Pacific Islander patients are more likely to use IT for clinical practice or prescription. Asian-American are the wealthiest ethnic group in the United States and are more likely to have access to high-quality healthcare. It is possible that healthcare providers in large Hispanic populations are not financially able to adopt and/or support these IT systems. This can have a direct impact on physicians' ability to provide high quality medical care and increase disparities in treatment provided to Hispanic patients.

Physicians who work in practices that get a greater percent of their revenue from Medicaid were significantly more likely to use IT for clinical practice and patient information. Medicare covers retirees and has been criticized by physicians for inadequate reimbursement rates and excessive paperwork (Connolly, 2009). On the other hand, physicians who work in practices that get a major percent of their revenue from Medicare were more likely to use IT for patient information only. Medicaid on the other hand covers low income families and covered by state and federal funds. The recently passed 2010 Patient Protection and Affordable Care Act made more people eligible to be covered under Medicaid. U.S. Department of Health and Human Services' Centers for Medicare and Medicaid Services has highlighted the need for physicians to utilize various health IT tools (Gibbons, 2011). Interestingly, financial assistance given to practices by health plans and other organizations tied to IT systems significantly impacted the use of IT in prescriptions, but had no significant impact on use of IT in clinical practice or patient information. In order to increase IT adoption, it is important that IT incentives are sufficiently large and also aimed at specific outcomes and not frequency of usage. In addition, healthcare providers, insurance companies, and government agencies have to act as a team to ensure that financial incentives are aimed at the right places (Bernstein, Chollet, & Peterson, 2010).

One of the limitations of this study is that the data was collected before the passage of the 2010 Patient Protection and Affordable Care Act and the 2009 American Recovery and Reinvestment Act. Both these legislations may have had an impact on IT usage by physicians. Future Health Tracking Physician Surveys will enable researchers to use the results of our study as a baseline for examining the impact of these federal legislations on use of IT by physicians. Another limitation of this study is that since the data was self-reported, physicians may over report usage of IT due to social desirability bias. It is also possible IT usage may be more in urban practices than in rural practices. Future research needs to examine this issue. In spite of these limitations, this study has important implications for health care policy makers, health care managers, and researchers on the use of IT among physicians.

CONCLUSIONS

The extent of use of electronic medical records by physicians and number of physicians in practice were the only factors that positively impacted the use of IT in clinical practice, prescriptions, and patient information. While competitive situation of practice, age of physician, primary care physicians, Asian and Pacific Islander patients, and revenue from Medicaid positively impacted the use of IT in clinical practice, a large proportion of Hispanic patients had a negative impact on the use of IT in clinical practice. The use of IT prescriptions were positively influenced by primary care physicians, Asian and Pacific Islander patients, and financial incentives, they were negatively influenced by a large proportion of Hispanic patients. Finally use of IT for patient information was positively influenced by age and income of physician and proportion of revenue from Medicare and Medicaid. It was negatively influenced by the level of ownership in private practice.

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ELECTRONIC PAYMENTS IN HEALTHCARE

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Abstract: In this paper the author has developed a theoretical framework for addressing the healthcare costs and based on it he has analyzed the payment system that is an integral part of healthcare payments. The author concurs with the recommendations made in earlier studies that switching from a paper-based system to an electronic system would not only reduce costs but also improve the efficiency of the system. By using an electronic payment system for payment of healthcare claims, huge savings can be achieved on an annual basis, as the numbers of claims processed each year are in the billions.

INTRODUCTION

Healthcare expenditures in the U.S. have been increasing not only in dollar terms but also as a percentage of GDP (Gross Domestic Product) since 1960. They have reached alarming proportions in recent years. Tables 1 and 2 highlight the seriousness of this problematic long-term trend.

Year	1960	1970	1980	1990	2000	2010
HCE Percent of GDP	5.2%	7.0%	9.0%	12.2%	13.8%	17.3%

Table 1: Healthcare Expenses [HCE] as a Percent of GDP: Long-Term View

Source: Adapted from National Health Expenditure Data: Historical, by U.S. Department of Health and Human Services, Centers for Medicare & Medicaid Services, 2011, retrieved from http://www.cms.gov/NationalHealthExpendData/02_NationalHealthAccountsHistorical.asp

In 1960, healthcare expenditures were 5.2% of the GDP and in 2010 they were 17.3% of the GDP. This indicates that healthcare expenditures are growing at a much faster rate than the GDP growth rate for the same time period. Average annual GDP growth rate for the period 1960–2010 has been 6.7% in nominal terms and the average annual healthcare-expenditure growth rate for the same period was 9.4% in nominal terms.

Year	GDP (in trillions of \$)	Healthcare expenses (in trillions of \$)	HCE as a % of GDP
2001	10.3	1.5	14.5%
2002	10.6	1.6	15.4%
2003	11.1	1.8	15.9%
2004	11.9	1.9	16.0%
2005	12.6	2.0	16.0%
2006	13.4	2.1	16.1%
2007	14.1	2.26	16.2%
2008	14.4	2.34	16.6%
2009	13.9	2.5	17.6%
2010	14.5	2.6	17.3%
2020*	26.1*	4.6*	17.6%*

Table 2: Healthcare Expenses, GDP, HCE as a Percent of GDP 2001–2010

Source: Adapted from National Health Expenditure Data: Historical, by U.S. Department of Health and Human Services, Centers for Medicare & Medicaid Services, 2011, retrieved from http://www.cms.gov/NationalHealthExpendData/02_NationalHealthAccountsHistorical.asp. Note: * indicates estimate

For the last 10 years (2001–2010), the average annual GDP growth rate has been 3.5%, and the average annual growth rate in healthcare expenditures has been much higher, at 5.7%. Also, Table 3 indicates that the healthcare expenditures for the U.S. constitute about 40% of the global healthcare expenditures for the last 10 years, whereas the U.S. only makes up 4.5% of the world population.

Year	U.S. healthcare expenses (in trillions of \$)	Global healthcare expenses	U.S.HCE as a % of global HCE
2001	1.5	3.0	50%
2002	1.6	3.4	47%
2003	1.8	4.0	45%
2004	1.9	4.4	43%
2005	2.0	4.5	44%
2006	2.1	5.0	42%
2007	2.26	5.6	40%
2008	2.34	6.0	39%
2009	2.5	6.0	42%
2010	2.6	6.3	41%

Table 3: U.S. Healthcare Expenditure as a Percent of Global Healthcare Expenditure: 2001–2010

Source: Source: Adapted from National Health Expenditure Data: Historical, by U.S. Department of Health and Human Services, Centers for Medicare & Medicaid Services, 2011, retrieved from http://www.cms.gov/NationalHealthExpendData/02_NationalHealthAccountsHistorical.asp; Global Lessons for Controlling Healthcare Costs, by P. Behner, R. Edmunds, & E. Powers, August 2011, *Strategy + Business Magazine*.

All these factors indicate that healthcare expenditures in the U.S. need to be moderated and the trends reversed. Policymakers, academicians, economists, and healthcare consultants agree that healthcare costs need overhaul and containment (Congressional Budget Office, 2008).

In this paper we will discuss relevant statistics to show that healthcare costs are abnormally high in the United States. In the second section we discuss the healthcare-revenue cycle and the healthcare-revenue time line. In the third section we discuss the theoretical model, value-chain model, to analyze the costs and develop the value-chain model for the healthcare sector. In this paper we focus only on healthcare-payment costs. Using the value-chain model for the healthcare sector, we analyze how healthcare-payment costs and efficiency of healthcare payments can be improved by switching from a paper-based system to an electronic system. Here, we discuss only the Automated Clearing House (ACH) payment system, which is an electronic payment system that is relevant for healthcare payments. Lastly, we present our conclusions.

HEALTHCARE REVENUE CYCLE

The healthcare revenue cycle can be thought of as a series of activities that are associated with the generation of revenues for healthcare providers. It is a highly complex process with numerous participants providing various services to individuals who can be thought of as the ultimate customers. Figure 1 provides an overall view of the process and its participants. The activities associated with the process can be broadly classified into three areas: pre-service, management of care, and post discharge. LeCuyer and Singhal (2007) provided an estimate of the aggregate number of transactions that take place at each stage for each activity shown in Figure 1 for the year 2006.

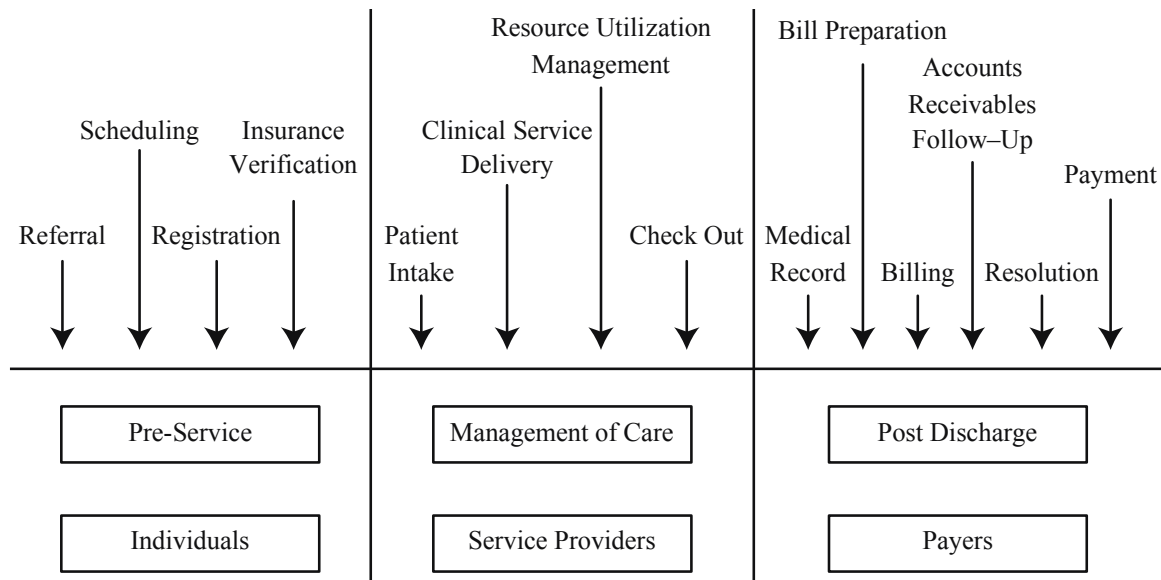


Figure 1: Healthcare Revenue Time Line

Source: (Modified from) Muller, Ralph. W., “Transforming Hospitals Through Reform of the Care Process” in *Engineering a Learning Healthcare System: A Look at the Future*, Eds. Grossmann, Claudia., Goolsby, Alexander.W., Olsen, Leigh, Ann., and McGinnis, Michael. J. The National Academic Press, 2011.

Table 4 shows an estimate of the number of transactions (in billions) that take place annually.

Type of Transaction	Annual Transactions (In Billions)	% of Annual Transactions that are Electronic
Eligibility Verification	1.4–3.5	30–50
Referrals/pre-authorization	0.6–1.6	10–25
Claim Submission	4.4–7.2	40–60
Claim status Check	0.7–2.4	30–50
Claim Remittance	1.2–3.4	40–60
Total*	8.3–18.1*	

Table 4: Estimated Transaction Volume between Healthcare Providers and Payers: 2006 Estimate

* The total does not include 3 billion pharmacy claims, 7 billion clinical-lab and pharmacy orders, 4 billion patient-to-provider payments, and 1 billion government-to-provider payments. Source: Adapted from Overhauling U.S. Healthcare Payment System, by N. A. LeCuyer & S. Singhal, June 2007, *The McKinsey Quarterly*.

The analysis is conducted at each step in the healthcare-revenue cycle in an effort to reduce the overall expenditures of the healthcare system in the U.S. Obviously, given the total value of the expenditures, the cost savings, if achieved, would be on the order of hundreds of billions of dollars, if not trillions. In this paper, we will only be looking at one particular process of the revenue cycle, namely the *payment process*. The Congressional Budget office (CBO, 2008) has estimated that a cost of \$300 billion per year is incurred by administrative costs by healthcare providers and public and private payers. LeCuyer and Singhal (2007) and Pellathy and Singhal (2010) indicated that the U.S. healthcare-payment system that processes more than \$2.5 trillion a year is quite “inefficient” by consuming 15% of each dollar spent in healthcare compared to 2% for the payment processing incurred by the retail industry.¹ The main reason is the high rate of electronic-payment processing used by the retail industry. The high administrative costs incurred by healthcare providers is attributed mainly to burdensome paperwork that requires manual handling of documents for claim processing, record keeping, and payments processing. Even after taking into account the complexity of the healthcare system, savings by the healthcare-payment system would be enormous by adopting a much higher rate of electronic-payment processing. Similar recommendations are advocated by researchers who have studied the problem (Pellathy & Singhal, 2010). In recent years, some large providers and payers have derived significant savings by using electronic submission and auto-adjudication of

claims, which has resulted in the shortening of the process cycle. These savings have only occurred on a small scale and a majority of claims processing, payments processing, and payments still use paper-based systems.²

VALUE-CHAIN MODEL

The value-chain model was first developed by Porter (1985) to increase the operational efficiency of private firms.³ According to Porter, a firm's competitive advantage increases due to the value the firm is able to create for its customers. This can come about in two ways: lower price for equivalent benefits or a special benefit that justifies a higher price. The value-chain model breaks down a firm into relevant value-added activities or processes in an effort to better understand the structure of underlying costs and benefits. These processes enable the firm to strategically analyze the value-added activities and processes to reduce costs or increase efficiency, or both. Figure 2 shows a firm conceptualized as a collection of value-added activities like inbound logistics and operations.⁴ Each of these value-added activities can then be analyzed, and based on this analysis, new procedures and processes could be developed, or existing ones modified to reduce costs or increase efficiency, or both. This type of analysis can be completed in the healthcare sector as well.

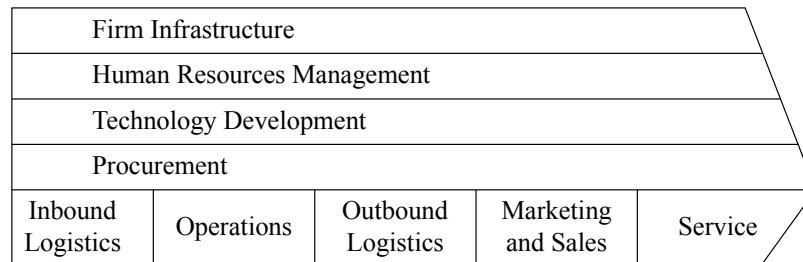


Figure 2: The Value Chain Model

Source: *Competitive Advantage: Creating and Sustaining Superior Performance*, by M. E. Porter, 1999, New York, NY: The Free Press.

VALUE CHAIN MODEL FOR THE HEALTHCARE PROVIDERS

Figure 3 shows how the value-chain model can be applied to the healthcare industry. For example, each of the activities shown in Figure 1 can be analyzed to reduce costs or improve efficiency, or both. Basically, individuals receive services from healthcare providers and healthcare providers receive payments for their services from payers like health-insurance companies, nonprofit organizations, government, and individuals. Healthcare providers also have a complex web of relationships with a host of other related service: providers like clinical laboratories, the pharmaceutical industry, healthcare equipment manufacturers, payers, etc. Table 4 shows various types of transactions that are associated with the complex web of relationships. These transactions are generally very large in scale and are on the order of billions of dollars for each type. Economic consultants have shown that converting these billions of transactions from paper-based systems to electronic systems can substantially reduce costs, increase efficiency, and dramatically reduce the scope for overbilling and other types of fraudulent claims (Trautman, Lisi, and Mayerick, 2010). In the next section we focus on cost reductions and improved efficiency that result from the implementation of electronic payments.

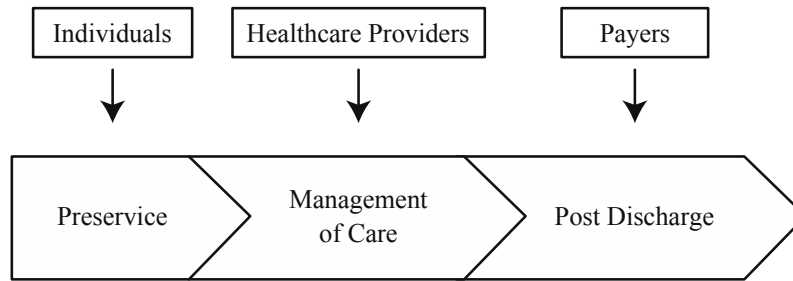


Figure 3: Healthcare Value Chain Model

Source: Adapted from *The Health Care Value Chain: Producers, Purchasers and Providers*, by L. R. Burns and Wharton School Colleagues, 2002, San Francisco, CA: Jossey-Bass.

ELECTRONIC PAYMENTS

The most widely used electronic-payment system in the United States is the ACH network, also referred to as the electronic funds transfer (EFT) system.⁵ Electronic payments have had a high rate of adoption in recent years in the areas of employee payroll, consumer bill payments, and federal or state government payments. It is also a low-value and high-volume payment system.

THE AUTOMATED CLEARING HOUSE (ACH) SYSTEM.

The ACH first was established in 1972 to provide an alternative to paper checks and to simplify the processing of paperless check transactions. In 1974, the National Automated Clearing House Association (NACHA) was established in order to develop a national ACH electronic network. By 1978, the United States had a nationwide ACH electronic network that was capable of transferring funds between accounts electronically. The ACH network was partially privately owned and partially owned by the Federal Reserve. Currently, the ACH network is an all-electronic-funds-transfer payment system that is used by more than 14,000 financial institutions, more than 3.5 million businesses, and more than 150 million consumers to make or receive EFTs. Table 5 shows that in 2010, 19.4 billion transactions were made with a value of over \$38 trillion using the ACH network. Today, 85% of ACH transactions are handled by the Federal Reserve. Also the ACH system has the capability to process healthcare payments efficiently. Currently, NACHA's primary role is to develop and maintain NACHA operating rules to promote the growth in ACH volume and to provide electronic solutions to improve the payment system. Their latest project is to promote electronic payments in the healthcare industry.

Year	Transaction volume (in billions)	Total Value of transactions (in \$ trillions)
2010	19.4	38.7
2009	19.1	37.2
2008	18.2	38.8
2007	18.0	36.6
2006	16.0	34.1
2005	14.0	31.1
2004	12.0	28.6
2003	10.0	27.4
2002	8.9	24.4
2001	8.0	22.2

Table 5: Automated Clearing House Annual Transaction Volume and Total Value of Transactions 2001–2010

Source: *ACH Primer for Healthcare*, by National Automated Clearing House Association, 2011a, Herndon, VA; Adoption of EFT and ERA by Health Plans and Providers (White Paper), by National Automated Clearing House Association, 2011b, Herndon, VA; The Federal Reserve System (2011), "The 2010 Federal Reserve Payments Study". Washington, DC: Author

Figure 4 shows the various participants associated with an EFT.

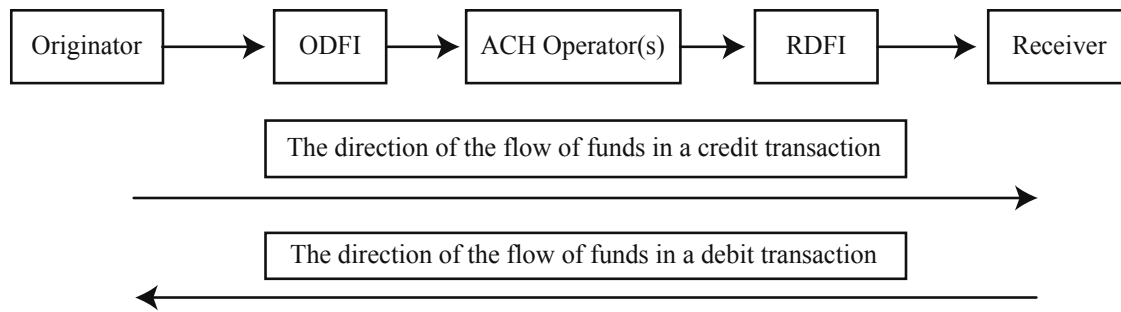


Figure 4: ACH Network Participants

Note: ODFI = originating depository financial institution; RDFI = receiving depository financial institution

The main participants in EFTs are the originator, the originating depository financial institution, the ACH operator(s), the receiving depository financial institution, and the receiver. NACHA operating rules provide the legal framework for effecting transactions through the ACH network and establish the responsibilities, liabilities, and warranties for various participants. The ACH is a high-volume low-value EFT system. Normally, it takes 2 to 3 days to complete a transfer. The ACH system is a credit and debit batch processing system. Financial institutions accumulate ACH transactions and send them to the ACH operator at predetermined times, rather than processing each transaction separately. The ACH system is able to process credit and debit transactions and fund transfers. Messages can be transmitted using appropriate formats. In a credit transaction, the originator initiates a funds transfer and the funds are transferred from the originator's account to the receiver's account. In a debit transaction, funds flow from the receiver's account to the originator's account. In this case, it is necessary to get preauthorization from the receiver. Figure 4 shows the direction of the flow of funds for both credit and debit transactions. The ACH system is a flexible system and accepts a variety of formats for different types of transactions.

In this section, we will discuss two formats that are relevant for healthcare payments. Two formats that are being standardized for healthcare payments are Corporate Credit or Debit Plus Addendum (CCD+) and Corporate Trade Exchange (CTX) formats. CCD+ format is designed for the transfer of funds within or between firms. Only a limited amount of remittance information can be sent using this format. The addenda record is 94 characters long and includes 80 characters of descriptive data. The CTX format is designed for company-to-company trade payments. It consists of a standard ACH transaction and a variable-length message addendum designed to include remittance information in the ASC X12 data standard. The addendum can accommodate 9,999 records of 80 characters each. CTX is used for payments related to multiple invoices and those with a considerable amount of invoice detail.

Apart from ACH, American National Standards Institute (ANSI) ASC X12 837 format can be used for electronically submitting healthcare claims by the providers in the context of electronic data interchange. ANSI ASC X12 835 format is used for electronic remittance advice (ERA) by the payer. In this case, CCD+ format is used to transfer funds. Combined ERA and EFT can be completed using CTX format and also CTX can be used for payment on multiple claims. Pilot studies by NACHA (2011d) have shown an estimated total savings of \$11 billion to \$30 billion per year by switching from paper-based payment system to a completely electronic-payment system. The cost of processing paper-based checks per claim is \$0.21 whereas using EFT the cost would be \$0.019 per claim. According to the pilot study, the estimated cost of paying 145 million claims using paper-based system is \$30.7 million, whereas the cost of paying 145 million claims using electronic system is \$2.7 million. In addition to the direct cost savings, the average time taken for claim processing is reduced from 49 days for the paper-based system to 14 days for the electronic system and the electronic system allows for consolidation of claims.

CONCLUSIONS

In this paper we developed a theoretical framework for addressing healthcare costs and based on that, we analyzed the payment system associated with healthcare payments. We endorse the recommendation of switching from a paper-based system to an electronic system that would not only reduce costs but also improve the efficiency of the system. By using an electronic-payment system for payment of healthcare claims, huge savings can be obtained on an annual basis, as the number of claims processed each year number in the billions.

ENDNOTES

1. Healthcare payments are compared with the retail industry because of the size involved. The retail industry processes \$9 trillion and healthcare processes \$2.5 trillion.
2. All these systems have to comply with numerous federal regulations; the discussion of regulations is beyond the scope of this paper.
3. Even though the value-chain model was developed for private firms, Burns (2002) discussed how these concepts can be applied to healthcare.
4. The vertical columns at the bottom of the figure indicate value-added processes; horizontal blocks at the top of the diagram indicate support functions.
5. There are three electronic-funds transfer systems in the United States. The other two, Fedwire and CHIPS, are not suitable for healthcare payments, as they address large-value payments and are more expensive to use.

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Examining the Use of Institutionally Designed Documentation Templates as a Vehicle for Changing Values and Practices in Health Care

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Abstract: Changing values and requirements are common occurrences in today's health care settings. Institutionally designed documentation templates are often developed to demonstrate that these changes have been incorporated into clinical work. Little research has been completed to examine whether the use of these institutional templates leads to the intended change or whether the changes clash with other influences on clinical work. This paper illustrates how two qualitative methods: think aloud interviews and frame analysis can be combined to examine the use of the templates, the changing values themselves, and the influences on changes in clinical practice. An analysis of local change from expert planning to person centered planning is used to illustrate the value of the approach. The analysis reveals influences that affect the adoption of this particular change, the usability of the template, and points of change that need to be negotiated with the users of those documents.

INTRODUCTION:

Health care in the United States is constantly changing due to new research findings, new technologies, changing service delivery systems, changing funding sources, and changing accreditation structures. Studying the impact of these changes on the practice of health care has been a particularly difficult problem attempted by only a few researchers (vanEyck and Baum, 2003). One common method for incorporating change into a health care system is to design templates for documentation that are intended to both guide the work and document the results. These templates then stand as evidence for accreditation organizations and third party payers that a particular type of clinical work is being done within that institution.

The salient question however is whether the templates actually lead clinicians to change their work in the ways that the institution would like them to. A particular combination of qualitative methods: think aloud interviews (from cognitive science) and frame analysis (a sociolinguistic approach) is effective in examining how clinicians use these templates and how the clinicians react to changes suggested by the templates, incorporating or not incorporating those changes into their work

In this combination of approaches, clinicians are asked to participate in a think aloud interview making their thinking processes and clinical approaches verbal while working their way through an institutionally-constructed template (Boren & Ramey, 2000). A frame analysis (Tannen, 1993) is then completed on the interview transcript. This analysis examines linguistic markers clinicians use to frame their work and their reactions to the values embedded in the institutionally-constructed template.

Although, the actual work of clinicians is not observed, the strength of the think aloud interview is the examination of the cognitive processes used in the completion of work (Nisbett & Wilson 1977). When the interviews are analyzed through frame analysis the tensions between institutional demands and other influences (such as clinical training) are revealed.

I offer an examination of community mental health center outpatient psychotherapists adjusting to person centered planning (a state mandated approach) as an example of this methodological combination.

INSTITUTIONALLY-CONSTRUCTED TEMPLATES AS A DEMONSTRATION OF PRACTICES

Institutionally constructed texts are constructed by administrators not only to document and guide the work of those within an institution, but also to demonstrate the value of important changes; indicating that those changes have been incorporated into practice (Ravotas and Berkenkotter, 1998). These texts also act as a form of accountability to outside regulators like insurance companies, managed care companies, and accreditation organizations. Since these texts are used for multiple purposes there are times that each of the purposes are not satisfied by the resulting text. Dauterman (1997), for example, examined the process of nurses' collaborative work developing policies and procedures and found that the pressure to conform to the demands of outside and internal regulators rendered the documents un-usable by their intended audience, nursing staff.

Documentation is a constant partner of clinical work in health care settings. It is not possible (nor preferable) for documentation to represent the complexity of clinical work. To focus the documentation institutional representatives frequently construct documentation templates (sometimes referred to as scripts or checklists). These institutionally constructed templates are heuristic documentation tools that are intended to clearly focus the work of clinicians on the institutional values and goals by structuring the work of the clinician, guiding the documentation of the work, and communicating information to other providers.

Templates, then, are used not only to document work but also to direct the work that is completed. Since templates are organized to define information that should be entered in each section, clinicians usually organize their work according to the template that they will need to complete. Rhodes, Langdon, Rowley, Wright & Small (2006) however found that electronic checklist templates used in diabetes consultation are sometimes used by nurses in a way that sets up a rigid agenda (to complete the form) that leaves patients with few openings to discuss their own agendas. In this study, even when a patient attempted to discuss his own concerns the nurse terminated the discussion with a minimal response, returning to the checklist as soon as possible. This, of course, raises flags in today's patient centered care environment.

Templates, themselves, can be interpreted by clinicians in many different ways and clinicians can adjust templates through their oral work with a client, which can adjust the purpose of the question. These adjustments made by clinicians may be important resistances or oppositions to the focus of a template (or an institution) and can point to a trajectory of change in the use of a template.

Institutional managers commonly design templates for intake forms, psychosocial assessments, history and physicals, treatment planning, consultations, family medical histories, daily notes, and discharge forms. Increasingly, templates are electronically-based and completed at the computer while working with the patient/client. Rhodes, Small, Rowley, Langdon, Ariss and Wright (2008) found that how nurses used electronic biophysical checklists (a form of template) within meetings with diabetic patients profoundly affected the patient's ability to raise topics in the meeting. Whenever clinicians use templates within a session they move back and forth from oral communication with clients to written documentation. Rhodes, et al. found that elements of this constant shifting from interview to documentation include not only verbal clues but non-verbal signals such as body position and gazing. All of these clues are used by patients to determine when and if they should contribute to the meeting. Patients often find it difficult to interrupt a meeting that is dominated by documentation needs; giving them limited input in the treatment process that is not scripted into the template (2008). The work of Rhodes et al. is unusual as there are few studies that examine the intersection of oral and written communication in health settings.

THE STRENGTHS OF THINKING ALOUD INTERVIEWS

Thinking aloud techniques (also known as verbal protocols) were originally developed by Ericsson and Simon as a method for studying the cognitive processes used in problem solving (1984). In this method of collecting data participants are given a task with defined steps and asked to "think aloud" as they illuminate how they would approach that task. Henderson, Smith, Podd, & Varela-Alvarez, (1995) found these protocol techniques to be the most effective usability approach as opposed to interviews, logged data, or questionnaires.

Other cognitive researchers have used think aloud strategies to compare expert vs. novice problem solving in business decisions (Minarik 2008), in artistic process (Fayena Tawil, 2007), in marketing (Reed, Dew, et al, 2009) and in the writing process (Hayes and Flower, 1983). Many of these researchers use an analysis method known as protocol analysis (Newell and Simon, 1972) to identify the process of thinking and decision making.

Health researchers also have used think aloud methods. Anastasi, Currie & Kim (2009) examined the diagnostic processes of traditional Chinese medicine practitioners, while Lutley, Campbell, Renfrew & Marceau (2008) examined how patient characteristics affected their physicians' treatment decisions. Think aloud strategies have also been used in examining the decision making processes of recipients of health care. These include the food selection process of obese and non-obese participants (Gray, 2006) and the decision making process based on myocardial infarction symptoms (anonymous 2009).

Thinking aloud protocols are also common in usability studies. Usability studies examine the effectiveness of tools in use (Dumas & Redish, 1993). Usability specialists examine the cognitive processes revealed in think aloud approaches to search for how participants approach the use of the tool. This approach recognizes that tool use must be understood as a situated action; an action set within a particular social, organizational and individual structure of work (Brown & Duguid, 1992; Spinuzzi 2001; Engestrom 1999). The human users within that organizational context often adapt and change that tool as it is used in accordance with other influences within the system and those influences that reside within the individual user (Adler & Winograd 1992).

The field of computer sciences extensively uses think aloud techniques to test the effectiveness of computer icons to guide computer work (Smith & Dunkley, 2002; de Mul & van Oostendorp, 1996). The use of these approaches has also spread to human factors engineering, technical communications, instructional design, questionnaire design, and cartography, to name a few (de Jong and Ramey, 2000). Two recent examples of computer science think aloud studies have focused on the use of library electronic search engines (George 2008) and student nurses' process of using e-learning resources (Cotton & Bresty 2007). Researchers in the area of medical informatics use think aloud strategies to guide their development of computer interfaces for use in medical practices (Jaspers, M. W. M, Steen, T, van den Bos, C; & Geenan, M; 2004)

When think aloud strategies are used in usability studies they are used to identify the elements of the tool that need to be changed. Most likely the spread of the study of usability is due to the intuitive notion that any type of tool (including a written template) might be analyzed for whether it is being used (in its present context) for its specified goal in its most effective way. It is surprising then that few studies exist examining the usability of written (or electronic) tools such as the institutionally-designed template.

I propose that thinking aloud can be used to study both the cognitive processes of health providers and the usability of tools that those health providers use. The most appropriate type of think aloud technique for this purpose is a think aloud interview with a speech communications emphasis. Boren and Ramey (2000) suggest that using a speech communications approach structures the actions of the interviewer in a way that supplements but does not derail the think aloud process. This semi structured interview allows initial, final, and clarifying questions. Smith, Podd, & Varela-Alvarez, (1995) found that the addition of an interview (rather than silent observation) increased interferences in the task and failed to add significantly to information about the usability of the tool. Later, however, Boren and Ramey (2000) found that the combination revealed important information about the use of the tool and did not seem to interfere with the process.

According to Boren and Ramey (2000) in the speech communications approach researchers are careful to define the user as the expert and the researcher as the listener or learner and direct the communication toward the goals of the study (which always includes the use of the product as the "subject" of the study)

FRAME ANALYSIS REVEALS CONFLICT

Tannen's (1993) frame analysis is a powerful tool for analyzing oral and written communication. She derived her framing theory from Bateson's (1968) concept of frames, Goffman's (1974) concept of footing and Shank and Abelson's (1977) concept of schemas.

Tannen (1993) has examined the language that people use that reveal how they are “framing” an understanding of what is happening in oral and written communication. According to Tannen, individuals enter any situation with a particular organization of knowledge: schemas they have from earlier experiences. These schemas are always carried into communicative activity and contribute to the sense making process. Linguistic frames then reflect the schemas underlying a person’s interpretation of a situation. Frames can also be indicated by non verbal communication (Rhodes, et.al 2008). Tannen points out that a clash in schemas (which indicates at least two different expectations) in a communicative activity leads to the necessary invoking of a new frame.

Frame analysis can examine shifts in frames as they occur within contexts by examining the linguistic markers that indicate a shift. Since frames reflect a person’s interpretation of the situation a frame analysis can detect when interpretations are developed from earlier sources including training, values, and developing practices. When applied to a think aloud protocol it also can grasp agreements and/or disagreements with the values behind a tool through an examination of recontextualization from one communicative activity to another (such as from an oral to a written text or from one written text to another). Recontextualization has been linked to changing practices by many researchers (Sarangi & Roberts, 1999; Ravotas and Berkenkotter, 1999; Linell 1998)

Tannen and Wallat (1993) analyzed the multiple frames that doctors use in doctor/patient communication. Frame analysis has been used by other researchers in a variety of contexts. Most recently, a common use of frame analysis is to analyze media frames. For instance, health communication researchers have used this approach to examine media frames regarding HIV/AIDS (de Souza 2007)

THE STRENGTH OF COMBINING A THINK ALOUD INTERVIEW AND A FRAME ANALYSIS

I would suggest that think aloud interviews have a specific frame structure because of the nature of the interviews. The purpose of this type of usability study is to have the user tell the story of the process of use. Therefore, the basic frame structure of this process falls into two large frame categories: the procedural frame and the explanation frame. Users go back and forth between these two large frames while working their way throughout their use of the tool.

The procedural frame is the actual telling of the process. It is marked linguistically with temporal phrases and self quotation such as “FIRST I...” “THEN WE...” “AT THIS POINT I ASK “WHAT ARE YOUR GOALS?””.

The explanation frame is the frame that users switch to when they want to explain their actions within the process. These explanation frames use a wider range of markers and linguistic structures because there are many ways that a person can explain their actions. However, a common example would be. “I ask that BECAUSE...”

Additional frames, however, are often used as subsets of each of these frames. In fact, the specific sub frames that are important in think aloud interviews of institutionally designed templates are institutional frames and community of practice frames. Institutional frames are frames that present or react to the institutional requirements and expectations. A common linguistic marker of this type of frame is a modal “We HAVE to...” “We MUST ask...” or a negative “This is NOT the best...”

Community of practice frames, on the other hand, are used to indicate the expectations the clinician has internalized from various communities of practice, including their training, professional organizations, and local practices. Linguistic markers are often emphatic expressions such as, “It is IMPORTANT...”, “The BEST way...” often mark community of practice frames.

Clinicians move back and forth between these two frames when they are explaining their actions (in the explanation frame). This is particularly the case when they are explaining actions that don’t fit securely into the institutional frame. Some linguistic markers indicate both the institutional frame and the community practice frame through the use of negatives, “This is NOT the best BECAUSE...” “This DOESN’T help the client...” “I WON’T do this...”

Another way that users shift from institutional frames to community of practice frames is demonstrated when the script portion of the template is rephrased. This change is noted within the procedural frame of the interview and it doesn't carry linguistic markers except for the changing of the words from the script. According to frame theories (Tannen 1993, Goffman 1974, Bateson 1972) rephrasing (a form of reframing) is done because it is more consistent with a person's schema of the activity that they are engaged in. In terms of health services the reframing makes more sense to the clinician in some way. It complements the work that he or she is involved in. This is generally because the reframing fits in with their professional way of completing the process or because they feel the patient/consumer would have a better chance of understanding the task as it is rephrased. Either way, this reflects a community practice; either the professional community out of which the clinician conducts his/her work or the immediate community of practice of the clinician and the patient/consumer.

Identifying the institutional frame as it is contrasted to the community of practice frame in the think aloud interview reveals the user's opposition to institutional requirements based on community of practice directives. It also reveals changes that the user is making in the use of the template. Finally, it points to possible future changes in either the template or the community of practice.

The combined approach of the think aloud interview and the frame analysis then produces data that reveals the structure of a clinician's schemas while approaching a specific task. Neither approach alone could produce data that can lead to a clear understanding of practice within the system as stated above.

Although I was unable to find other researchers who used this specific combination of approaches, I was able to find a study based on a think aloud strategy with a linguistic analysis. Phansalkar (2007) examined the decision making strategies of pharmacists using a verbal protocol while conducting a chart review to detect adverse drug events. When a semantic analysis was done on the results of the protocol analysis the researcher was able to identify textual signals that were used by pharmacists that had been overlooked by other professionals. Phansalkar proposes that the textual signals might be incorporated into expert computer systems to detect adverse drug events.

UNCOVERING THE COMPLEXITY OF INFLUENCES ON CLINICAL WORK AND DOCUMENTATION

To illustrate the power of this combination of methods I will use some data from a study conducted in a community mental health center outpatient department. I completed think aloud interviews with all five psychotherapists in a small community mental health center on their use of a Person Centered Planning template. I then conducted a usability analysis to examine whether the tool had been used in the way it was intended and a linguistic frame analysis to extend the study to a micro level of resistances and changes to the template and institutional values.

Person centered services (or patient centered services) have become important throughout the health field in a variety of disciplines. Several researchers have examined difficulties in the transition to patient centered care. Rogers, Kennedy, Nelson & Robinson (2005) found in their interviews with physicians and patients regarding self management of irritable bowel disease that while physicians thought that planning sessions were patient centered; patients felt that some of their concerns were not included in the planning sessions. Furthermore, they also found that parameters of the health care setting itself (such as limited time with patients, an inflexibility of scheduling despite the limits of the disorders in question, and poor continuity of care) interfered with the patient centered planning. Rogers, et. al. emphasized the importance of considering the practitioner and patient input as well as the organizational system when designing patient centered care.

Milton (2009) examined how health innovations such as electronic health records have the potential to impact person centered services. Before examining the use of electronic checklists in planning sessions Rhodes, et al. (2006) interviewed patients to determine the concerns that they wished to discuss in the planning session with a nurse. However, when those patient concerns were brought up by the patient they were not addressed adequately by the nurse who returned to the electronic screen. Later, Rhodes et al (2008) found that although the use of electronic checklist templates presented a challenge to patient centered services some nurses were able to attend to patient's concerns while using the templates.

Person Centered Planning is a legal requirement of the Michigan Mental Health Code (1996) and therefore; the law mandates that all clinicians in all the departments of Michigan community mental health centers must demonstrate their use of person-centered planning. This legislation was passed into law to assure that the values of self-determination would be applied to all of the mental health services provided in the state. It represents a shift from expert driven planning sessions, conducted and dominated by the expert clinician; to the consumer as an active planner, creating a plan that is driven by the needs and desires of that consumer who sets his/her own goals based on preferences, strengths and abilities rather than on diagnoses or problem categories.

The need for this paradigm shift from expert to consumer driven planning is not only supported by self determination advocates (Pierpont, 1990; Snow, 1992) but also by a series of researchers examining psychotherapy and/or medical encounters (Maynard 1991, Mischler 1984). Ainsworth-Vaughn (2002) found that physician's maintain power in interviews with patients as they are occurring and in the direction of future action through a series of linguistic moves such as ritualized routines and phrases. Ferrara (1994) found the same pattern in psychotherapy sessions. In one case study, Hak and DeBoer (1995) found, that a therapist consistently interrupted a client's narrative account to "extract" objective symptoms and then through a series of modeling activities encouraged her to accept and participate in his formulation of the problem.

One challenge of incorporating person centered planning into the therapist-consumer relationship is that the relationship is perceived by both participants as hierarchical. Consumers seek therapy to avail themselves of the expertise of the therapist while the therapist is trained to use his/her expertise in planning and conducting psychotherapy. The shift to person centered planning challenges these roles at least to some extent and is a difficult shift that is mediated by an institutionally-constructed documentation template, intended to explicitly draw the consumer into the planning process

The interviews for this study were conducted within the first few years of the legislative change so it coincides with the time period in which person centered planning was beginning to be incorporated into the work at mental health centers.

Self determination advocates (Pierpont 1990, Snow 1992) stress the importance that any type of intervention should arise from the global dreams and hopes of an individual. Michigan mandates concur. According to the Michigan Mental Health Code (1996 revision):

"Person-centered planning is a process for planning and supporting the individual receiving services that build on the individual's capacity to engage in activities that promote community life and that honor the individual's preferences, choices and abilities. The person-centered planning process involves families, friends and professionals as the individual desires or requires" (330.1712)

According to the Self Determination Policy and Practice Guidelines (Michigan Department of Community Health 2003, p. 1) "PCP is the crucial medium for expressing and transmitting personal needs, wishes, goals and aspirations." In other words treatment and intervention goals set within the community mental health system must arise from these global dreams of the consumer.

Administrators of most community mental health centers in response to this mandate developed training for clinicians in self determination and person centered planning and developed institutional templates to guide the process.

Two sections of the PCP template used in this study are particularly salient to the fostering of self determination and the transition from expert based to consumer based planning. These sections are section #2: "My Dreams, Desires, and Goals" and section #8 "Goals and Objectives". Section #2 was written to identify these global guiding elements of a consumer's life that can then later be used to set goals and objectives for the planning process in section #8. The use of these sections then is intended to support the basic values of self determination.

A usability analysis of the think aloud interview was helpful in identifying a number of points in the use of the template at this particular mental health center. All of the psychotherapists interviewed used the templates within the session to guide their actions. They also all used some parts of the PCP template like a structured interview and/or script: reading the question and writing down the response. Even though they often read the question

verbatim, all of the psychotherapists also reframed some of the sections of the template before asking the questions and or added their own interpretation after reading the question. Some of these interpretations changed the meaning of the question. Therapists frequently changed the “My Dreams, Desires, and Goals” by reframing the printed phrase to the consumer. Only one of the therapists quoted this directly and then wrote down the consumer’s response. The other therapists all narrowed the focus of this section through rephrasing the statement and thereby, changing the intention of person centered planning. Some of the rephrasing includes, “Where do you see yourself in five years?” “What do you think you will do next?”, “What are your plans for the future?” and “Last time we met you wanted to work on...is that still your goal?” While each of these questions is valid they do not address the larger “dreams, desires, and goals” of the person centered plan.

Therapists also did not base their joint development of treatment goals and objectives on the global “dreams, desires, and goals” of the consumers or even connect the goals to what was written down in the earlier section. None of the therapists made a connection between the two. These findings point to the fact that the document was not being used in the manner it was intended. This level of analysis certainly suggests changes within the template are warranted. In particular, the template itself should make an explicit connection between the “My Dreams, Desires, and Goals” section and the “Goals and Objectives” section.

The linguistic frame analysis however goes beyond the usability dimensions to identify patterns in the adjustments and decisions made by psychotherapists. In the procedural frame the rephrasing of “My Dreams, Desires, and Goals” shifts the work from the institutional frame to the community of practice frame. All of the psychotherapists reframed this statement to a smaller, more accomplishable goal.

The explanation frame of the cognitive interview suggests that therapists narrow the “dreams, desires, and goals” section to goals that are possible to accomplish in psychotherapy. Psychotherapy practice went through major changes in the 1980s and 1990s leading to shorter term therapy and more sharply defined treatment goals. This emphasis is reflected in the therapist’s responses. Most of the therapists spontaneously supply an explanation for why they rephrase the section, apparently recognizing their deviation from the institutional mandate.

One therapist points out that the institutional frame (the statement itself) leads to responses that must be adjusted to be useful in therapy. “ ‘My dreams, desires and goals’...you have to kind of rephrase that for them... ‘Well, what are your plans for your future?’ And so, you break that down for them and... ‘Maybe, you want to be a doctor...but, well let’s get through high school.’...so, you know realistic goals help them.”

This therapist suggests a community of practice frame by references to the activities of a therapist (the use of the pronoun “you” implies that she sees these activities as a common action of therapists not idiosyncratic to her, and that she is connecting to the interviewer who is also a psychotherapist). She also indicates her perceived necessity of adjusting the wording for the consumer through her use of the words “for them” and “help them” as in “...rephrase that for them...break that down for them...realistic goals help them...” She then goes on to contrast the institutional frame induced response “Be a doctor” with a substitute goal “get through high school” invoking the value of “realistic goals” and thus returning to a community of practice frame.

Another therapist implies that these type of global dreams are “too ethereal” for the work of psychotherapy. She also does not use the institutional phrasing but rephrases to specific goals for therapy. Her explanation frame implies that not only is the institutional phrasing unworkable, but that it has a ridiculous element to it that is not grounded in psychotherapy practice., “...sometimes it’s like ‘Your dreams desires...’ (sing-songy voice) is kind of too ethereal for people (laugh)..you know, ‘I want to be Queen’ (pretend voice)

While none of the therapists use the “My Goals, Desires & Dreams” section (# 2) to develop the treatment plan, three of the five therapists prewrite this section (# 8) of the PCP from the preliminary PCP (completed on the first day that the consumer has come to the clinic-in a screening process). Although the next excerpt is selected from one interview, other therapists had very similar responses, Then the goals...they usually told me on that preliminary PCP what they want to work at... I put it in goals and objectives form and put it on here...then I lead them to this and say, “Is this ok with you?” I have had few people object.”

The next excerpt introduces a psychotherapist’s frustration with institutional paperwork being imposed

on the therapy process. Note the way the therapist moves from Institutional frame to Community of Practice frame. It is clear that this therapist sees the documentation process as a process that interferes with the consumer's needs and desires. She is ironically referring to the patient centered planning documentation. They have waited a really long time to get...some help...So, once they get to the therapist after the whole intake process...screening process...finally they are in the therapist's office, sometimes, they fall apart right away... they are ready to do the work...and so it is real difficult for me to say, "Whoa, wait a minute, we have to do this paperwork and so that is a difficulty that I have...I can't just sit and comfort someone...or let them talk or tell me their story...therapy, that I think works really well with people who are really having trouble...I have to be more concrete than they are ready to be in the first session.

The modal in this segment (have to) indicates the institutional frame that the therapist is invoking, "we have to do this paperwork" (line 17)... "I have to be more concrete" (line 29). She also indicates the contrasting community of practice frame with the negative construction, "I can't just sit and comfort someone" (lines 23-25). The therapist is commenting on what she sees as two very different work expectations: The institutional expectation of foregrounding the completion of paperwork in that first session vs. the professional psychotherapist expectation that when the consumer is "ready to do the work" the therapeutic dyad begins to work on the problem. It is not unusual for psychotherapists to see paperwork and particularly the PCP as separate of the real work they are involved in. This is mentioned throughout the usability interviews.

Finally, most of the therapists point to the difficult task of balancing the consumers' goals with the expert role as a therapist, pointing out that therapists often must step in and help consumers see the urgency that some goals must have over others. To qualify as an outpatient consumer in today's mental health system consumers must have persistent mental illness and often have life damaging behaviors, therefore this is a very real concern.

"they don't always have their priorities on the same order as I do...and I will change the goals and we will negotiate as necessary but...(you realize this too as a therapist)...I can't say well 'yeah, you are trying to commit suicide every day, but we are just not going to talk about that because you don't want to...Yeah, there is a compromise and some negotiating of goals..."

This therapist uses a frame construction that starts out with a strong personal stand against institutional mandates, marked by the repetitions of the pronoun "I", but then switches into a professional therapist community of practice frame through her aside to the interviewer "...You realize this too as a therapist..." (lines 9-11). She then contrasts the institutional and the community of practice frames with the help of a constructed example. One of the interesting things to note in this example is that she uses a negative that actually negates the consumer, "you don't want to" (lines 17-18). This has the effect of blending the institution and the consumer together, indicating that she disagrees with the power that the institution has given the consumer in this case.

Based on the usability interview and frame analysis this researcher was able to meet with the therapists and administrator to discuss the results and offered the following suggestions.

1. Write into the template an explicit connection between the "My Dreams, Desires, and Goals" and the "Treatment Plan" sections to prompt the therapists to consider the intended connection between the two.
2. Open a dialogue regarding the conflicts psychotherapists feel between their work as psychotherapists and the person centered planning process. This dialog should include: a. conflicts between the previous training of narrowing a focus and the PCP value of using global dreams; b. when psychotherapists should use their expert power to guide away from inappropriate consumer goals; and c. when psychotherapists should move away from paperwork functions to the urgent needs of a consumer.
3. Open a dialogue regarding the practice of pre-writing and what pre-writing makes sense from earlier documents.

CONCLUSION

Changes from expert centered to patient centered care are not unique to the mental health segment of health services, this is an ongoing trend that will continue as more health care systems take on this value. Yet, this is only one of a host of other changes made in health care all of the time. These changes, by their very nature challenge earlier values and ways of doing things. Changes, in turn, are often challenged by those seeing value in the earlier approaches. Identifying elements of this conflict can go a long way toward maintaining quality services throughout the change process. Since these changes are often reflected in the development and use of institutionally designed

templates a combination of think aloud interviews with both a usability analysis and a linguistic frame analysis offers a powerful tool for examining the intersection of values embedded in their use.

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Towards the National Health Information Network in the United States of America

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Abstract: The Health Infrastructure in the U.S. is called the National Health Information Network (NHIN) which is composed of regional Health Information Exchange (HIE) hubs. This approach has been exercised since 2008. However, there is a lack of one top-down comprehensive architecture of this system, which is being developing by each state individually. This paper provides the top-down model of such architecture, perhaps the first one which is made. The paper defines basic components of that system. Also some issues of security and privacy of stored and exchanged data are disputed. In the end, the paper provides conclusions regarding the issues of its implementation.

INTRODUCTION

This investigation contains the background of the current policy of the U.S. National Health Program (2011), it particularly identifies the components of that program, which later will be integrated into an architecture of health information infrastructure. Its security and privacy issues will be discussed. The conclusion will assess the feasibility of the presented architecture.

The Health Infrastructure in the U.S. is called the National Health Information Network (NHIN) which is composed of regional Health Information Exchange (HIE) hubs. This approach has been exercised since 2008. HIE is defined as the mobilization of health care information across organizations within a region, community, or hospital system. The goal of HIE is to facilitate access to and retrieval of clinical data to provide safer, more timely, efficient, effective, equitable, patient-centered care. HIE should be also useful to Public Health authorities to assist in analyses of the health of the population (Woolhandler and Himmelstein 1997).

HIE systems should facilitate physicians and clinicians in meeting high standards of patient care through electronic participation in a patient's continuity of care with multiple providers. Secondary health care providers should benefit through reduced expenses associated with duplicate tests, time involved in recovering missing patient information, paper, ink, associated office machinery, manual printing, scanning and faxing of documents, the physical mailing of entire patient charts, manual phone communication to verify delivery of traditional communications, referrals, and tests results. According to an internal study at Sushoo (FL) HIE, a single-clinician practice spends \$17,160/year associated with the current method of exchanging patient's health information (retrieved on 2010-5-31 <http://www.sushoo.com/sushoo-demo.html>).

SECURITY ISSUES OF THE NATIONAL HEALTH INFORMATION NETWORK

Recent revelations of "secure" data breaches at centralized data repositories, in banking and other financial institutions, in the retail industry, and from government databases, have caused concern about storing electronic medical records in a central location. Records that are exchanged over the Internet are subject to the same security concerns as any other type of data transaction over the Internet.

The Health Insurance Portability and Accountability Act (HIPAA) was passed in the US in 1996 to establish rules for access, authentications, storage and auditing, and transmittal of electronic medical records. This standard made restrictions for electronic records more stringent than those for paper records. However, there are concerns as to the adequacy of implementation of these standards in practice.

PRIVACY ISSUES OF THE NATIONAL HEALTH INFORMATION NETWORK

One major issue that has risen on the privacy of the U.S. network for electronic health records is the strategy to secure the privacy of patients. Former US president Bush called for the creation of networks, but federal investigators report that there is no clear strategy to protect the privacy of patients as the promotions of the electronic medical records expands throughout the United States. In 2007, the Government Accountability Office reports that there is a “jumble of studies and vague policy statements but no overall strategy to ensure that privacy protections would be built into computer networks linking insurers, doctors, hospitals and other health care providers” (Pear 2001).

The privacy threat posed by the interoperability of a national network is a key concern. One of the most vocal critics of EMRs, New York University Professor Jacob M. Appel, has claimed that the number of people who will need to have access to such a truly interoperable national system, which he estimates to be 12 million, will inevitably lead to breaches of privacy on a massive scale. Appel has written that while “hospitals keep careful tabs on who accesses the charts of VIP patients,” they are powerless to act against “a meddlesome pharmacist in Alaska” who “looks up the urine toxicology on his daughter's fiancé in Florida, to check if the fellow has a cocaine habit” (Francis 2006). This is a significant barrier for the adoption of an EHR. Accountability among all the parties that are involved in the processing of electronic transactions including the patient, physician office staff, and insurance companies, is the key to successful advancement of the EHR in the U.S. Supporters of EHRs have argued that there needs to be a fundamental shift in “attitudes, awareness, habits, and capabilities in the areas of privacy and security” of individual’s health records if adoption of an EHR is to occur (Nulan 2001).

So far, The U.S. Department of Health and Human Services takes no action on complaints under HIPAA, and medical records are disclosed under court orders in legal actions such as claims arising from automobile accidents. HIPAA has special restrictions on psychotherapy records, but psychotherapy records can also be disclosed without the client's knowledge or permission. For example, Patricia Galvin, a lawyer in San Francisco, saw a psychologist at Stanford Hospital & Clinics after her fiancé committed suicide. Her therapist had assured her that her records would be confidential. But after she applied for disability benefits, Stanford gave the insurer her therapy notes, and the insurer denied her benefits based on what Galvin claims was a misinterpretation of the notes. Stanford had merged her notes with her general medical record, and the general medical record wasn't covered by HIPAA restrictions (Nulan 2001).

BASIC DATA ENTRY OF THE NATIONAL HEALTH INFORMATION NETWORK

The whole HIE architecture is based on a set of related electronic data entry (records), for

- Electronic Medical Records about patients (EMR)
- Electronic Laboratory Records (ELR)
- Electronic Image Records (EIR)
- Computer Physician Order Entry (CPOE) at hospitals
- Electronic Pharmacy Records (EPR)
- Personal Health Records (PHR) collected by individuals and eventually shared with appropriate health care providers
- Disease Management System (DMS), maintained by Insurers
- Other

The advantage of these electronic records is that they can “talk to each other” and reduce chaos and errors. In the United States, Great Britain, and Germany, the concept of a national centralized server model of healthcare data has been poorly received. Issues of privacy and security in such a model have been of concern.

(Retrieved on 2010-5-31; e-Health Insider (UK). January 2008. http://www.e-health-insider.com/news/3384/german_doctors_say_no_to_centrally_stored_patient_records).

Privacy concerns in healthcare apply to both paper and electronic records. According to the average medical practice, roughly 150 people (from doctors and nurses to technicians and billing clerks) have access to at least part of a patient's records during a hospitalization, and several, providers and other entities that handle providers' billing data have some access also (e-Los Angeles Times).

ARCHITECTURE MODEL OF THE NATIONAL HEALTH INFORMATION NETWORK

Within the private sector, many companies are moving forward in the development, establishment, and implementation of medical record banks and health information exchange.

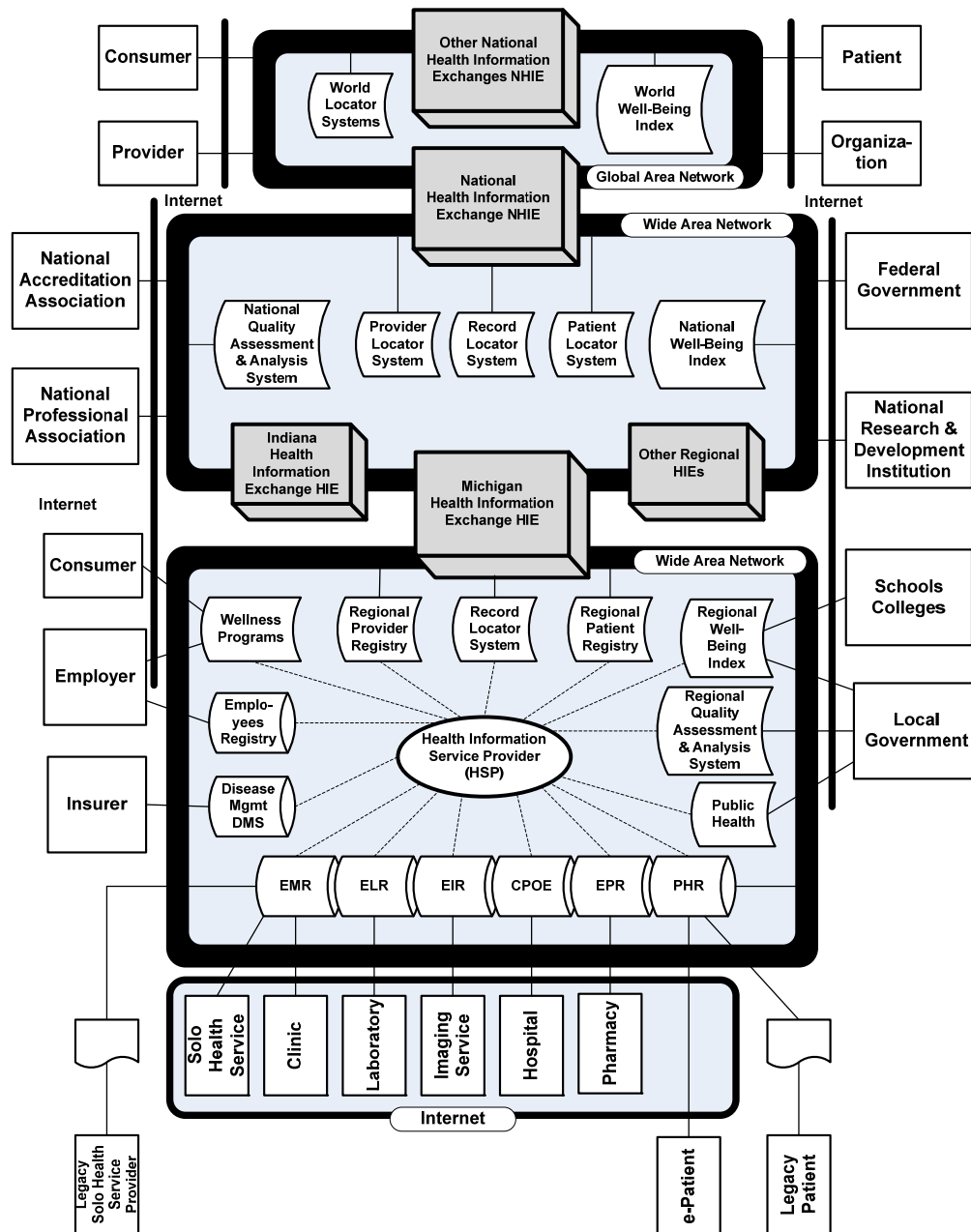


Figure 1. The Architecture of National Health Information Exchange Network for the U.S. (2010)
(EMR-Electronic Medical Record, ELR-Electronic Laboratory Record, EIR-Electronic Image Record, CPOE-Computerized Physician Order Entry, EPR-Electronic Pharmacy Record, PHR-Personal Health Record (The Targowski Model))

By law, companies are required to follow all HIPAA standards and adopt the same information-handling practices that have been in effect for the federal government for years. This includes two ideas: standardized formatting of data electronically exchanged and federalization of security and privacy practices among the private sector. Private companies have promised to have “stringent privacy policies and procedures.” If protection and security are not part of the systems developed, people will not trust the technology nor will they

participate in it. So, the private sector knows the importance of privacy and the security of the systems and continues to advance well ahead of the federal government with electronic health records.

In health care files and databases, paper-based systems are difficult to keep updated and to share with other health care providers and users. If a given health care provider does not have good enough information technology at hand, it can acquire services of independent Health Information Services Providers (HISP).

The architecture of Health Information Exchange Network is depicted in Figure 1. This architecture (according to this author) is based on *private* Wide Area Networks (WAN) and Global Area Network (GAN) and the Internet. The U.S. Office of National Coordinator for Health Information Technology (ONC) plans the use of the Internet only. It is recommended contrary to American businesses' practice which organized data transmission on private networks (MAN, WAN, GAN, VAN) due to higher security than which can be achieved on the Internet. According to the ONC, the NHIE will apply software which will comply with the access and security standards defined in the CONNECT Project.

The presented architecture of the HIE Network includes two very important systems at the regional and national levels: the Quality Assessment and Analysis System (QAAS) and Well-Being System (WBS). Furthermore, there planned at the regional and national levels; locators of records, patients, and providers.

SYSTEMS OF THE NATIONAL HEALTH INFORMATION NETWORK

The planned National Health Information Network has the following four levels of information processing systems:

- Level 1 “Local” – Includes health service providers, such as: health clinics, health laboratories, imaging services, hospitals and so forth. At this level health service data about patients (consumers, employers, insurers) are entered under systems' form of
 - Electronic Medical Records (EMR),
 - Electronic Laboratory Records (ELR),
 - Electronic Pharmacy Records (EPR),
 - Personal Health Records (PHR), and other.
- Level 2 – “Regional” – Includes health insuring employers, insurers, local governments, and so forth, which create the State Health Information Exchange (HIE) services, which will use the following systems;
 - Operational systems: Employees Registry, Regional Patient Registry, Regional Provider Registry, and Record Locator System,
 - Quality control systems: Regional Well-Being Index, Regional Quality Assessment & Analysis System, Public Health System,
 - Program Informing Systems: Disease Management System, Wellness Program, and so forth.
- Level 3 “National” – Includes federal government, national research & development institutions, national accreditation associations, national health professional associations which create the National Healthy Information Exchange (NHIE) and will use the following systems:
 - Operational systems: Provider Locator System, Patient Locator System, Records Locator System,
 - Quality control systems: National Well-Being Index, National Quality Assessment & Analysis System
 - Gateways to other regional HIE(s)
- Level 4 “International” – includes foreign health services providers, insurers, which provide services for the American patients or the American health services providers which provide services for foreign patients being treated in the U.S. They will apply the following systems:
 - Operational systems: World Locator System
 - Quality control system: World Well-Being Index.
 - Gateways to National HIE (s).

These systems create a complex system environment, which should be planned, design, and implemented with the mix strategy, including top-down provided standards and bottom-up data entry processes, controlled by the local, national, and international users. This kind of the system complex is difficult to implement, since the health care industry, the largest business in the world, is full of contradictory goals and strategies. Very often the planned “chaos” serves better than the organized systems?

CONCLUSION AND THE FUTURE WORK

At the time of publishing this paper (August 2011), the author is rather pessimistic about possibility of successful implementation of this architecture. The American national political and societal climate is negative for large-scale and innovative initiatives (Lee and Mongan 2009). The status quo is the most popular policy among established political and professional leaders (Woolhandler and Himmelstein 1997). This is because the 19th century attitude was supposedly very successful in developing of Americanism (efficient way to wealth and “happiness”).

Unfortunately, after the passing of almost two centuries, today we enter a new epoch of new societal issues and required solutions, which require bold conceptualization and tough choices, through the 21st century (Porter and Teisberg 2006). However, despite of these new challenges the most powerful country in the world must search for new ways to wealth and happiness of its citizens (Targowski 2009).

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Examining Structural Constraints and Electronic Health Record Use in Acute Care Hospitals

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Abstract: Electronic Health Record (EHR) use is expected to quickly increase in the USA. It is the hope of the federal government and many hospitals that EHR use will not only increase, but also mature from basic applications such as EHR for results viewing (ERV) to more advanced applications such as Computerized Provider Order Entry (CPOE). Today, considerable heterogeneity exists among hospitals with regard to EHR use and the movement toward advanced EHR applications. Examining this heterogeneity is useful as hospitals move toward advanced EHR. Survey data collected from 297 acute care hospitals in 47 states suggests that critical access hospitals may be slow to use EHR, even in the early stages of ERV. Conversely, major teaching hospitals appear to be early adopters, achieving advanced ERH use. These findings are key for hospital executives, Health Information Technology managers, and policymakers facing resource allocation decisions for EHR adoption.

INTRODUCTION

Healthcare spending in the U.S.A. is expected to reach \$4 trillion in 2015 – roughly 20% of gross domestic product (GDP) (Borger, Smith, Truffer, Keehan, Sisko, Poisal, et al., 2006; Bourgeois, Prater and Slinkman, 2009). These cost increases have led to a “...call for increased adoption and use of health care information technology (HIT) to address structural inefficiencies and care quality issues plaguing the US health care industry (GAO, 2005),” (Trimmer, Cellucci, Wiggins and Woodhouse, 2009: p. 55). According to Katsamakas, Janamanchi, Raghupathi and Gao (2009: p. 19), “HIT has the potential to transform the healthcare industry by increasing productivity, reducing errors and costs, facilitating information sharing and improving the quality of healthcare services (Brailer, 2005).”

Growth in hospital use of HIT is on an upward trend (Bourgeois et al., 2009). This growth is primarily led by two applications; computerized provider order entry systems (CPOE), and picture archiving computer systems – or electronic health records use for results viewing (ERV) (Dorenfest, 2004). These applications (ERV and CPOE) signify a sort of *functional sophistication* (Bourgeois et al., 2009). ERV can be defined as basic electronic health record (EHR) use and CPOE can be defined as advanced (or comprehensive) EHR use (Jha, DesRoches, Campbell, Donelan, Rao, Ferris, et al., 2009). Unfortunately, the adoption and use of these EHR technologies has been less than expected (Reardon, 2009), and heterogeneous among hospital providers (McCullough, Casey, Moscovie and Burlew, 2011). In other words, while all hospitals use EHR to some degree, the levels of sophistication vary considerably (Cohen, 2005).

The heterogeneity in EHR use among hospitals may be contingent on a variety of factors present in a hospital's environmental or operational context (Helms, Moore, and Ahmadi, 2008; Spil, LeRouge, Trimmer and Wiggins, 2009). One key contingency in such an operational context might be a hospital's structural constraints such as location or type (Li, Benton and Leong, 2002). For instance, a high volume teaching hospital treating highly acuity patients may be more likely to adopt advanced EHR applications than critical access hospitals which encounter less competition and possess fewer resources (Hough, Chen and Lin, 2005; Helms et al., 2008). Given the considerable investment afoot for EHR, it would be valuable to better understand some of the adoption patterns of specific hospital types (Bourgeois et al., 2009). Understanding contingencies may “...help to smooth IT implementation in the future,” (Spil et al., 2009; p. 70).

This study explores hospital adoption of EHR by examining two unique cases of structural constraints – major teaching hospitals (MTH) and critical access hospitals (CAH) (Li et al., 2002). In doing so, this study seeks to

inform two key research questions facing policymakers, hospital executives, and HIT managers. First, are certain hospital types more advanced than others with respect to EHR use? And second, if so, what contingencies may be driving this heterogeneity in EHR use? This study addresses these research questions by developing hypotheses linking hospital type to basic and advanced EHR use and testing these hypotheses using survey data collected from 297 hospitals in 47 states. Results reveal that CAH are behind in their implementation of EHR at even the basic level of results viewing. MTH are more established in terms of their EHR use, outpacing mainstream facilities at even advanced levels such as computerized provider order entry.

VARIABLES AND HYPOTHESES

The contingency perspective contends that the achievement of many organizational initiatives can be linked to contextual factors (Jayaram, Ahire and Dreyfus, 2010). These contingency factors can arise in the form of structural constraints such as the location, size, and/or teaching status of the hospital that may influence operational practices and outcomes (Li et al., 2002). The way contingency factors affect a hospital's use of EHR is of interest in this study. Thus, contingency theory is used to underpin the overarching notion posited by this study that the operational context of the hospital – its structural constraint as a MTH or CAH – will influence its use of basic or advanced EHR. CAH are postulated to exhibit lower levels of EHR use, namely in the range at, or below, that of basic EHR, while MTH are theorized to exhibit higher and more advanced EHR use (CPOE). Variables are defined in table 1.

Subconstruct	Definition	Literature
Basic EHR use	the extent to which a hospital uses electronic health records for results viewing purposes (e.g., lab reports, consultant reports, etc.).	AHA, 2005; Cutler et al., 2005; Jha et al., 2009.
Advanced EHR use	the extent to which a hospital uses electronic health records for Computerized Provider Order Entry (e.g., lab tests, consultation requests, etc.).	AHA, 2005; Cutler et al., 2005; Jha et al., 2009.
Critical Access Hospital	the extent to which a hospital is 1) located in a rural area, 2) located more than 35 miles away from any other hospital (or 15 miles in mountainous terrain), 3) maintain not more than 25 inpatient beds, and 4) maintain an annual average length of stay (ALOS) of 96 hours or less.	HRSA, 2010; McCullough et al. 2011.
Major Teaching Hospital	the extent to which a hospital is affiliated with a medical school and maintains teaching and research as core to its mission.	Li et al. (2002); McDermott and Stock (2007); Jha et al. (2009).

Table 1. Variable Definitions.

Critical Access Hospitals and EHR Use

CAH are designated as such owing to their strict compliance with certain criteria. See table 1. CAH “face many challenges in health IT adoption including financial constraints, limited access to capital, inadequate infrastructure, and limited health IT workforce,” (McCullough et al., 2011: p. 329). While many concur that IT will improve safety and reduce errors, barriers to implementation are many (Hartzema, Winterstein, Johns, de Leon, Bailey, McDonald, and Pannell, 2007).” For these reasons, their operational context appears to hinder CAH's adoption of EHR, even basic for results viewing. Therefore, this study postulates,

H1: Critical access hospitals will demonstrate lower levels of basic EHR use (Results Viewing) than non-critical access hospitals.

Hospital IT adoption has been slow, above all with advanced IT applications such as EHR (Reardon, 2009). Often EHR use is hampered by several factors. “Lack of competition, resistance to change, and capital costs are among the major causes for healthcare’s slowness to adopt IT (Hough et al., 2005),” (Helms et al., 2008: p. 81). In light of these contextual factors, it is not expected that even non-critical access hospitals will be mature in the adoption of advanced EHR. Therefore, this study postulates,

H2: Critical access hospitals will demonstrate the same levels of advanced EHR use (CPOE) as non-critical access hospitals.

Major Teaching Hospitals and EHR Use

MTH are dissimilar from non-teaching facilities in terms of their goals and mission (Li et al., 2002). These hospitals are affiliated with medical colleges, and take on extra responsibilities such as research (McDermott and Stock, 2007). Thus in this study, major teaching hospitals are defined as the extent to which a hospital is affiliated with a medical school and maintains teaching and research as core to its mission (Li et al., 2002; McDermott and Stock, 2007; Jha et al., 2009). Their involvement in research positions these facilities to be on the cutting edge best practices (McDermott and Stock, 2007). The present study builds upon the literature which suggests that MTH are more likely to adopt innovative practices, in this case centered on EHR use. Therefore, this study postulates,

H3: Major teaching hospitals will demonstrate higher levels of EHR for CPOE (advanced EHR) use than non-major teaching hospitals.

Other researchers have hypothesized differences in the practices of teaching and non-teaching hospitals and found no statistically significant differences (see Goldstein and Naor, 2005; Tucker, Nembhard and Edmondson, 2007). McFadden, Henagan and Gowen, 2009). These mixed results may be owing to the notion that MTH are only different in the most advanced practices. Mainstream hospitals follow MTH in their adoption of new practices, thereby closing the gap on what was formerly thought of as *cutting edge*. Therefore, this study postulates,

H4: Major teaching hospitals will demonstrate the same levels of EHR for Results Viewing (basic EHR) use as non-major teaching hospitals.

Comparing Critical Access Hospitals and Major Teaching Hospitals

In sum, this discussion points out key differences between CAH and MTH. Given their differing operational contexts (financial and human resources, etc.), it should be expected that MTH demonstrate a high level of EHR use at both the basic and advanced varieties. Therefore, this study postulates,

H5: Major teaching hospitals will demonstrate higher levels of EHR for Results Viewing (basic EHR) use and of EHR for CPOE (advanced EHR) use than critical access hospitals.

RESEARCH METHODS

Data collection

Survey data was collected using a cross-sectional self-administered survey of American Hospital Association (AHA) members. The sample frame consisted of 671 hospital executives from 644 acute care facilities. 312 responses were received, generating a response rate of 46.5% (312/671). After deleting responses for missing or inappropriate values and averaging duplicative responses, the analysis sample consisted of 297 hospitals. Sample characteristics are displayed in tables 2 and 3.

Characteristics	Respondents
Job title	
Director of Case Management	63 (21%)
Chief Nursing Officer	43 (15%)
Vice President of Patient Care Services	43 (15%)
Director of Nursing	21 (7%)
Director of Quality Initiatives	17 (6%)
Quality Assurance Manager	14 (5%)
Director of Patient Care Services	10 (3%)
Chief Operating Officer	7 (2%)
Unit Manager	6 (2%)
Vice President of Quality Initiatives	4 (1%)
Chief Executive Officer	2 (1%)
Vice President of Medical Affairs	1 (0%)
Vice President of Case Management	1 (0%)
Other	47 (16%)
Did not report.	22 (7%)

Note: Numbers represent frequency, followed by the percentage (rounded) of the sample in parentheses.

Table 2. Respondent characteristics (job titles).

Characteristics	Respondents
Hospital type	
Tertiary care center	66 (22%)
Community hospital	188 (63%)
Critical access hospital	34 (11%)
Other/missing values	9 (3%)
Ownership status	
For-profit hospital	39 (13%)
Non-profit hospital	222 (75%)
Public hospital	30 (10%)
Other/missing values	6 (2%)
Size – number of beds	
< 49	39 (13%)
50-99	59 (20%)
100-199	64 (22%)
200-399	76 (26%)
> 400	53 (18%)
Other/missing values	6 (2%)
Teaching status	
Major teaching hospital	59 (20%)
Minor teaching hospital	92 (31%)
Nonteaching hospital	141 (48%)
Other/missing values	5 (2%)

* Hospitals from 47 states participated in the study.

Note: Numbers represent frequency, followed by the percentage (rounded) of the sample in parentheses.

Table 3. Sample characteristics.

Finally, tests for non-response bias produced no statistically significant differences for targeted demographic variables between the respondents and non-respondents providing evidence that non-response bias is not problematic in the data (Armstrong and Overton, 1977).

DATA ANALYSIS AND RESULTS

Measures

Exploratory factor analysis (EFA) was employed to assess simple factor structure among the variables (Hair, Black, Babin, Anderson and Tatham, 2006). The items displayed in Table 4 were analyzed collectively using SPSS 15.0. This fashioned a total explained variance of 80.3%, and a Kaiser-Meyer-Olkin value of 0.79 indicating a suitable number of factors present in the model (Hair et al., 2006) to explain the EHR phenomenon under study as well as to provide evidence of sampling accuracy. Factor loadings were generated using Principle Components Analysis extraction method and Varimax rotation method with Kaiser Normalization. The number of factors was not specified in the analysis. This revealed a simple factor structure of two factors, both of which demonstrate Eigenvalues > 1 . Item coefficient values were suppressed at < 0.4 values given that these are considered small (Hair et al., 2006) and not indicative of cross-loading.

All factors loadings are above 0.5, demonstrating convergent validity (Bagozzi and Yi, 1988) and all exceed 0.7 which Hair et al., (2006) considers indicative of well-defined structure. Evidence of discriminant validity is provided as none of the loadings are greater than 0.4 on more than one factor (Hair et al., 2006). Content validity was confirmed by the literature review and theory development. Cronbach's alpha was employed as a test of reliability. Both factors scored over 0.90 and are therefore acceptably reliable measures (Hair et al., (2006). See Table 5.

Measurement items	EHR for results viewing	EHR for Computerized Provider Order Entry
<i>We use EMR to view:</i>		
ERV2 radiology reports.	0.93	
ERV1 lab results.	0.91	
ERV4 diagnostic test results.	0.90	
ERV3 radiology images.	0.87	
ERV5 diagnostic test images.	0.81	
<i>We use EMR to order:</i>		
CPOE2 radiology tests.		0.95
CPOE1 laboratory tests.		0.95
CPOE4 consultants reports.		0.90
CPOE3 medications.		0.87
CPOE5 nursing orders.		0.82
<u>Notes:</u>		
1. Extraction Method: Principal Component Analysis.		
2. Rotation Method: Varimax with Kaiser Normalization.		

Table 4. Operational definitions and exploratory factor loadings (factor structure).

Correlations among the variables and descriptive statistics are provided in Table 5. It should be noted that correlations exist among the variables at a $p < 0.01$ level. This is likely owing to the similarity in the wording of the questions as well as the theoretical construction of the variables both dealing with EHR use (see Table 4 for the operational definitions/items). The correlation is well below the 0.90 cutoff as a measure of collinearity suggested by (Hair *et al.*, 2006). Lastly, the variables were tested for kurtosis and skewness, neither of which were shown to be problematic.

Variable	μ	σ	Skewness	Kurtosis	α	Corr.
EHR for results viewing	4.56	0.57	-1.95	6.20	0.92	n/a
EHR for Computerized Provider Order Entry	3.57	1.06	-0.75	-0.01	0.94	0.189***
<u>Notes:</u>						
Sample $n = 297$						
Corr. = correlation between the two variables significant at *** $p < 0.01$.						

Table 5. Descriptive statistics.

Hypothesis Testing

T-tests were employed to test the hypotheses theorized in this study. The t-test is a statistical procedure used to assess mean differences between groups or samples (see Hong, Dobrzykowski and Vonderembse, 2010), and have been used in similar studies of EHR (McCullough *et al.*, 2011). Table 6 displays the results for the testing of hypotheses 1 and 2 with regard to CAH.

Variables and means	Basic EHR use (ERV)	Advanced EHR use (CPOE)
Critical access hospitals ($n = 34$)	4.36	3.30
Non-critical access hospitals ($n = 263$)	4.58	3.61
t-value	2.20**	1.77 ^{n/s}

**Significant at $p < 0.05$. Scale anchors: 1 = strongly disagree, 5 = strongly agree.

Table 6. T-tests for critical access hospitals.

Hypothesis 1, *critical access hospitals will demonstrate lower levels of basic EHR use (Results Viewing) than non-critical access hospitals*, is supported as CAH ($\mu=4.36$) are statistically different (lower) than non-critical access hospitals ($\mu=4.58$) at the $p < 0.05$ level ($t=2.20$) in terms of their use of basic EHR. Hypothesis 2, *critical access hospitals will demonstrate the same levels of advanced EHR use (CPOE) as non-critical access hospitals* is also supported as CAH ($\mu=3.30$) are not statistically different from non-critical access hospitals ($\mu=3.61$) in terms of their use of advance EHR.

Table 7 displays the results for the testing of hypotheses 3 and 4 with regard to MTH. Hypothesis 3, *major teaching hospitals will demonstrate higher levels of EHR for CPOE (advanced EHR) use than non-major teaching hospitals*, is supported as MTH ($\mu=3.89$) are statistically different (higher) than non-critical access hospitals ($\mu=3.49$) at the $p < 0.01$ level ($t=3.04$) in terms of their use of advanced EHR. Hypothesis 4, *major teaching hospitals will demonstrate the same levels of EHR for Results Viewing (basic EHR) use than non-major teaching hospitals*, is also supported as MTH ($\mu=4.60$) are not statistically different from non-major teaching hospitals ($\mu=4.55$).

Variables and means	Basic EHR use (ERV)	Advanced EHR use (CPOE)
Major teaching hospitals ($n = 59$)	4.60	3.89
Non-major teaching hospitals ($n = 238$)	4.55	3.49
t-value	0.57 ^{n/s}	3.04***

***Significant at $p < 0.01$; ** $p < 0.05$. Scale anchors: 1 = strongly disagree, 5 = strongly agree.

Table 7. T-tests for major teaching hospitals.

Table 8 displays the results for the testing of hypothesis 5 which examines differences between CAH and MTH. Hypothesis 5, *major teaching hospitals will demonstrate higher levels of EHR for Results Viewing (basic EHR) use and of EHR for CPOE (advanced EHR) use than critical access hospitals*, is supported as MTH ($\mu=4.60$) are statistically different (higher) than non-critical access hospitals ($\mu=4.36$) at the $p < 0.05$ level ($t=2.03$) in terms of their use of basic EHR as well as in terms of their use of advanced EHR in which case MTH's $\mu=3.89$, while CAH's $\mu=3.30$ (statistically significant at $p < 0.01$; $t=3.11$).

Variables and means	Basic EHR use (ERV)	Advanced EHR use (CPOE)
Critical access hospitals ($n = 34$)	4.36	3.30
Major teaching hospitals ($n = 59$)	4.60	3.89
t-value	2.03**	3.11***

***Significant at $p < 0.01$; ** $p < 0.05$. Scale anchors: 1 = strongly disagree, 5 = strongly agree.

Table 8. T-tests comparing critical access and major teaching hospitals.

DISCUSSION AND CONCLUSIONS

Hospitals in the U.S.A. are under tremendous pressure to implement EHR (McCullough et al., 2011) and as a result substantial investment in HIT is underway (Bourgeois et al., 2009). The movement toward better integration and

improved collaboration anticipated to result from EHR is an important goal for even the smallest rural hospitals (HRSA, 2010). Unfortunately, EHR use is not universally achieved among hospitals. This study examines differences in EHR use among acute care hospitals in the U.S.A. in an attempt to provide a much needed understanding of current trends and provide direction for improvement (Spil et al., 2009). As such, this study produces valuable finds for practitioners and scholars alike.

For practitioners, data from 297 acute care hospitals from 47 states reveals that hospital EHR implementation is indeed heterogeneous. Critical access hospitals appear to be lagging behind the curve in terms of their adoption of even basic EHR. Conversely, major teaching hospitals are leading the way demonstrating high levels of basic as well as advanced EHR use when compared to critical access hospitals. These findings inform the first research question under study, *are certain hospital types more advanced than others with respect to EHR use?* This is a key finding as this study provides empirical evidence illustrating the heterogeneity in EHR adoption, and in doing so, uncovers EHR trends among specific hospital types based on a hospital's context or structural constraints (Li et al., 2002). Through literature review, this study informs the second research question, *what contingencies may be driving this heterogeneity in EHR use?* Following the establishment of heterogeneity between critical access hospitals and major teaching hospitals, the key characteristics of their operating contexts emerge as important contingency factors in their implementation of EHR. For example, these findings should draw attention to the observations made by McCullough et al. (2011) and Helms et al. (2008) who suggested that critical access hospital suffer from limited access to capital, financial constraints, inadequate infrastructure, and limited health IT workforce. It follows that while major teaching hospitals may appear to have greater need for, and ability to achieve the integration realized by EHR owing to their contingency factors of high levels of patient acuity, operating complexity, and substantial resources (Li et al., 2002), true system integration can only be achieved when all healthcare providers use EHR. As such, additional resources (financial as well as human) would be well served to be dedicated for EHR implementations in critical access hospitals.

This study makes two primary contributions for scholars. First, it provides a rare theoretically grounded examination of EHR use. Contingency theory (see Jayaram et al., 2010) is shown to be an effective theoretical lens for understanding the motivations of certain hospitals to implement specific types of EHR while others do not. In this way, contingency theory may help scholars to better explore EHR trends, an important undertaking in the effort to smooth future implementations (Spil et al., 2009). This lens was also key in the development of the findings put forth for practitioners. Second, this study employed a rare multi-item approach to measuring EHR. This is a valuable approach in providing a rich measure of both EHR for results viewing, framed as basic EHR, and EHR for computerized provider order entry, framed as advanced EHR. These measures have been shown to be both highly valid and reliable. Previous studies have analyzed individual measurement items while ignoring the phenomenon as an aggregate psychometric measure (see McCullough et al., 2011).

LIMITATIONS AND FUTURE RESEARCH

While this study does contribute to the scholarly and practical understanding of EHR use, it is plagued by certain limitations. First, the limitations consistent with survey research (i.e., challenges related to respondent bias and measurement of perceptions) are possible owing to the single respondent data collection method employed by this study. Second, the focus of this study was on the contingency factors or structural constraints that may influence EHR use. Certainly, other factors may influence EHR use that were not included in this study, and are worthy of future investigation. Finally, while important insights are provided into the differences between critical access hospitals and major teaching hospitals in terms of their EHR use, this represents but a small fraction of the potential learnings. Clearly more work is needed to explore phenomena related to EHR as encouraged by Spil et al. (2009: p. 70) who pointed out the need for "...continuous learning, evaluation, and understanding in both practice and research."

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Electronic Health Records (EHR) Implementation and Post Implementation Challenges

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Abstract: The US Healthcare Industry lags behind other industries in its use of technologies for process improvement and improvement in quality of services for its patients. Globally, United States is significantly behind some European and Australian countries in implementation of EHR. While the federal government is now mandating this change and also offering incentive programs, healthcare providers remain slow to comply because of challenges they face regarding EHR implementation. This paper discusses EHR architecture, presents implementation challenges, provides a case study and offers future research ideas. The information provided in this research could be beneficial for successful EHR implementation.

INTRODUCTION

The US Healthcare Industry generally lags behind other industries in its use of technologies for process improvement and improvement in quality of services for its patients. Globally, United States is significantly behind some European and Australian countries in implementation of EHR. Even in 2004-2005, more than half of healthcare providers in Sweden, the United Kingdom, the Netherlands, and Australia were using EHR (Ash & Bates, 2005; Podichetty & Penn, 2004). Studies have shown that along with the improvement in quality, efficiency, and effectiveness, many medication errors, which are the most common cause of preventable injuries in hospitals, can be prevented by such EHR systems (Torda, Han, Scholle, 2010; Poon, E. G., Blumenthal, D., Jaggi, T., Honour, M. M., Bates, D. W., & Kaushal, R. 2004). While the federal government is now mandating that providers transform from paper to electronic health records (EHR), several studies point to the fact that healthcare providers remain slow to comply because of many challenges they face (Stikeman, 2001; Coile, 2002; Bates, 2003; Bakhtiari, 2010). EHR is a complex endeavor. While Electronic Medical Record (EMR) represent record of health-related information on an individual by a single organization (Figure 1), EHR is a highly complex multi-organizational collaborative process of health-related information of an individual (Figure 2). The complexity of EHR varies depending on architectural style, for example, a platform-based EHR tend to be more homogeneous and simpler compared to a provider-based or a patient-based EHR.

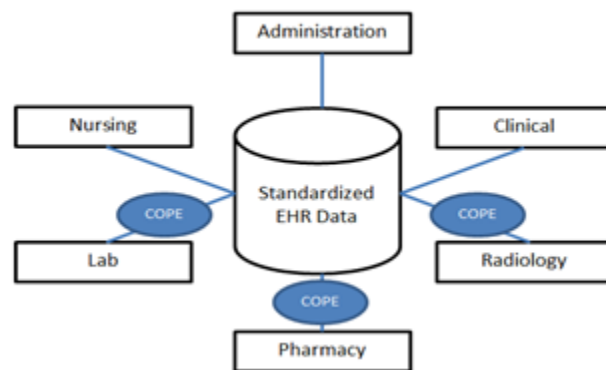


Figure1: EHR Concept – Single Provider

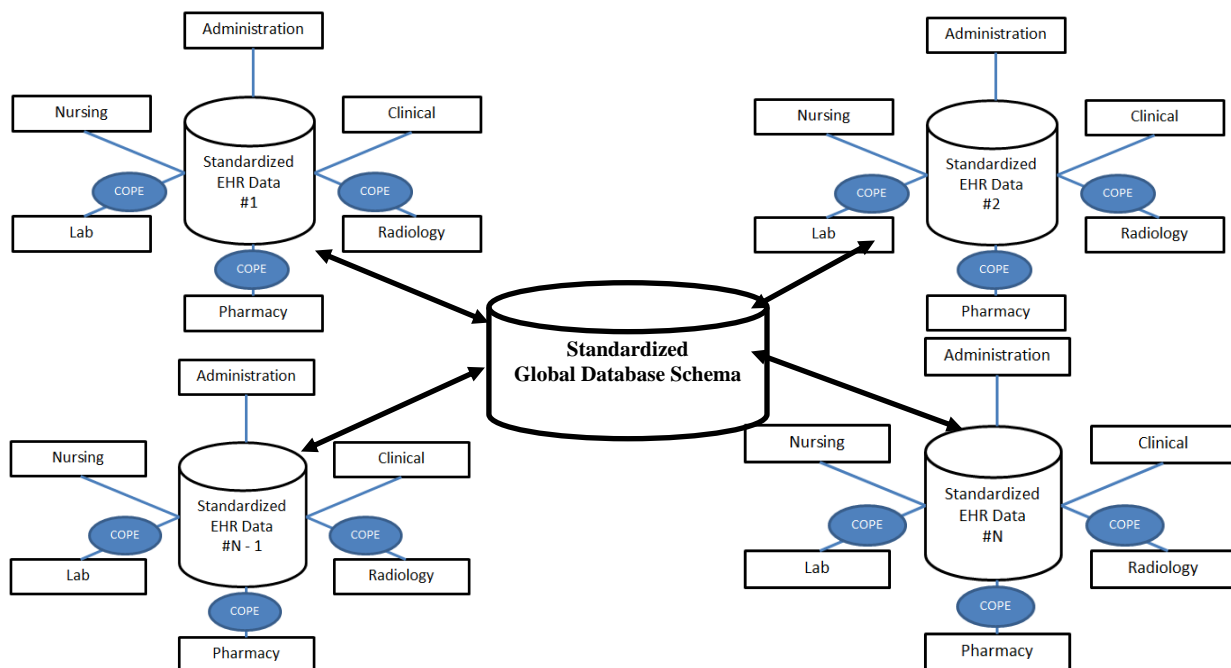


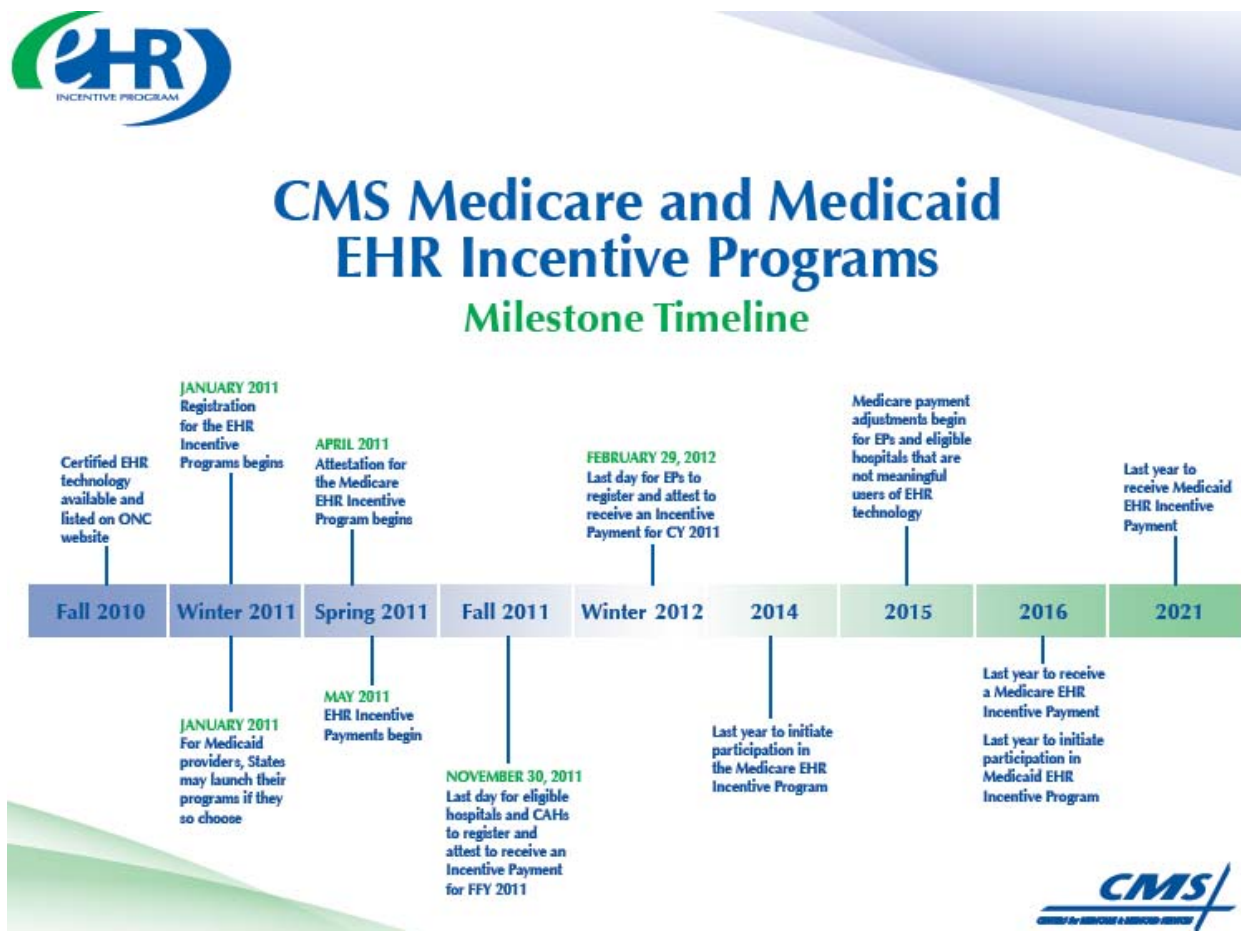
Figure 2: EHR Concept – Multiple Providers

As with any complex integrated system, some components are standard and others vary by facility. Following is a list of standard EHR components.

1. Administrative component: Patient, admissions, discharges, and transfer information (National Committee for Vital Health Statistics, 2002)
2. Laboratory component: Orders of tests, results, and billing information.
3. Radiology component: Orders of images, results, and billing information. Lorenzetti (2003) mentioned that about 80% of institutions had this capability in 2001.
4. Pharmacy: Automated entry of prescription drugs is highly desirable and would eliminate manual entry error (Ondo and Hess, 2005).
5. Computerized physician order entry (CPOE): CPOE allows integration of 2, 3, and 4 components. CPOE is a must and should also be compatible with other EHR components.

6. Document Repository: EHR must allow providers to capture notes, assessments, and generate reports whenever needed.
7. Compliance Checker: This component consists of E-Consent system and Compliance system. This component could possibly be done by a third party checker for simplicity and cost effectiveness.

US government is also offering Medicare and Medicaid EHR Incentive Programs for EHR adopters (Figure 3). Medicare and Medicaid EHR Incentive Programs provide 'incentive payments to eligible professionals, eligible hospitals and critical access hospitals (CAHs) as they adopt, implement, upgrade or demonstrate meaningful use of certified EHR technology' (<http://www.cms.gov/ehrincentiveprograms/>).



Source: <http://www.cms.gov/EHRIncentivePrograms/Downloads/EHRIncentProgtimeline508V1.pdf>

Figure 3: Medicare and Medicaid EHR Incentive Programs

The purpose of this study is to identify EMR/EHR components, prepare a list of EHR implementation and post implementation challenges and present a case study. In the previous section, we have already provided simple schematic diagrams of EMR and EHR. In the next couple of sections we present our findings on EHR implementation and post implementation challenges followed by a case study. Conclusion and future research directions are provided last.

EHR: IMPLEMENTATION CHALLENGES

Jha, DesRoches, Kralovec, & Joshi (2010) in a recent survey of U.S. hospitals, found that the share of hospitals adopted either basic or comprehensive EHR has risen modestly, from 8.7 percent in 2008 to 11.9 percent in 2009. Small, public, and rural hospitals were less likely to embrace electronic records than their larger, private, and urban counterparts. Only 2 percent of U.S. hospitals reported having electronic health records that would allow them to meet the federal government's "meaningful use" criteria. Another study reported that only 20% of practicing physicians and 9% of all healthcare facilities have begun and/or completed the transition to EHRs (Lohr, 2008). These findings underscore the fact that the transition to a digital health care system is complex, challenging, and likely to be a long one. There exist many EHR adoption/implementation challenges. A few of the EHR implementation challenges are listed below:

1. Lack of an appropriate policy towards EHR adoption
2. Lack of technical expertise, Isolation of data, Lack of knowledge about best practices
3. Unrealistic expectations on implementation scope, time, funding, implementation disruptions etc.
4. Lack of understanding of the benefits of EHR, and how to extract maximum benefit from the system.
5. Developing a sustainable business model
6. Adoption of e-consent and adoption of CPOE
7. Resistance to process re-engineering. Practice redesign and quality improvement methods are integral to successful use of the full capabilities of EHR. (Torda, Han, Scholle, 2010).
8. Bad experience with a previous implementation
9. Security, communication, training requirements, etc.
10. Availability of expert help during implementation and post-implementation stability phase
11. Availability of experts in legal, financing, and regulatory issues
12. Revenue may decline during implementation process

EHR: POST IMPLEMENTATION CHALLENGES

Process change: Old habit die hard

As with all new implementations, the most obvious change is workflow related change, and EHR is no exception. Everyone including administrators, physicians, nurses, and ancillary staff need to start capturing, retrieving, and sending information electronically instead of paper based storage, retrieval, and communication. Appropriate training at all levels before going live with EHR is critical. The success of any implementation depends on how quickly end users are able to use the system efficiently and effectively.

Technology change

EHR is totally dependent on complex and compatible working components of many hardware and software. Therefore, making sure that all of these components work properly is critical. A team of experts internal or outsourced need to be available 24/7 at least for several months to a year.

Policies and Procedures

Management need to implement standard process control for creation, modification, update, and implementation of policies and procedures. Since IT is in the core of EHR, management responsible for policies and procedures need to keep the IT department in the loop. It is standard IT practice to have a change control policy to ensure that changes are approved and properly tested before being added to the production environment.

CASE STUDY: ANONYMOUS MEDICAL CENTER (ANMC) IN THE MIDWEST

Anonymous Medical Center has been using EHRs for over 15 years. Their first implementation was a product called ProTouch made by a Trilogy, a small software company. It was UNIX based and, while very basic, met

ANMC's needs for many years. Each client computer had a small installation of the program that communicated with a number of servers. ANMC had three or four employees on-site and ProTouch was maintained by four employees at the company that provides the software for several clients. It became apparent that the needs of the user group - mainly nurses and people entering physician orders (business associates, health unit coordinators or ward secretaries as they are sometimes referred) - were quickly outpacing the system's capabilities. So, in 2004 ANMC and its parent company partnered with Cerner Corporation for the implementation of their next generation EHR.

For a number of years ANMC only had its intensive care units (ICUs) using Cerner. Senior leadership determined that the Cerner system was too costly to have just four ICUs (five at the time the decision was made) using Cerner and developed a plan to roll the EHR out to the rest of the hospital campus and to the physician practices affiliated with ANMC and their two smaller hospitals. In addition, ANMC's parent company piloted a new initiative and share resources with another member of the parent company's family in New York. To date they are the only such implementation and it has proved to be a challenge given that the two health systems have different state regulations, but must agree on the content of their EHR.

The strategy for rolling Cerner out to the rest of the health system involved intensive planning sessions between IT and stakeholders in different clinical areas around the hospital coupled with a series of staggered and phased go-lives with 24x7 support. Some units went live with orders and documentation, while others went live only with the ability to view documentation until the legacy EHR was phased out. This approach, while cumbersome, allowed for analysts to support go-lives while simultaneously giving IT more time to address the go-live needs of areas with special needs or more complex clinical workflows. Other larger sister hospitals with a greater IT presence opted for a "big bang" strategy where multiple sites/facilities went live with full functionality concurrently.

ANMC decided to have Cerner remotely host the database servers and application servers at their data center in the Midwest rather than have those servers on-site and use their own staff for server maintenance. One of the downsides of having a remote hosted mission critical application is that if the wide area network (WAN) goes down for any reason then the whole system becomes unusable until connectivity is restored. This downside is overcome at ANMC by having several "fat client" installations on-site that download patient data every 15 minutes just in case connectivity is disrupted for an extended period of time. Each unit has several of these PCs that function as regular workstations during normal operation, but would also serve as a critical component in the downtime plan.

LESSONS LEARNED

1. Modest achievable goals
2. One or more trusted implementation partners
3. Comprehensive implementation strategy sessions
4. Phased go-lives with 24x7 support
5. Robust backup plan

CONCLUSION

In spite of the extraordinary size of the Healthcare Industry in the United States today, its implementation of information technology is surprisingly low. This is best represented by the extremely low percentage of physicians currently using Electronic Health Records. However, this practice will soon change as the federal government established the goal of creating an EHR for every US citizen by 2014. To aid in this process, the American Recovery and Reinvestment Act was created in 2009.

While many providers are cognizant of these government mandates, they are slow to transition from paper to electronic records for many reasons. Some do not see the benefit of EHRs. Others do not understand the database, hardware, and/or software needed to run such a system. Many providers are unaware of the incentives being offered for compliance. Finally, those who are able fear the post implementation problems and worry about the system hindering their processes and the care they provide their patients. We have, in this paper, discussed EMR/EHR

schema and identified quite a few implementation challenges. A case also has been presented to provide a real-world scenario of EHR implementation.

Change is never easy for individuals or organizations and it is only natural for healthcare providers to resist drastically changing their established process for maintaining patient records. However, by understanding the concerns of the workers, their objections can be overcome. In addition, educating doctors, nurses, and other front line healthcare workers in the benefits of Electronic Health Records will provide justification for the temporary discomfort they experience while transitioning. Currently, the diagnosis of the Healthcare Industry is that it is too slow in its implementation of information technology. However, healthcare providers can use the information provided in this research for EHR implementation success.

FUTURE RESEARCH DIRECTION

Several authors have mentioned one or more of the challenges mentioned in previous sections (Torda, Han, Scholle, 2010; Kulkarni, 2006; Miller, West, 2007; Valerius, 2007; Weber, 2005; Gupta, Murtaza, 2009; DeVore, Figlioli, 2010), however, a comprehensive study on understanding multi-dimensional challenges emanating from complex EHR implementation does not exist. Patten (2005) studied implementation of CPOE and concluded that along with some success with CPOE implementation, there had been many failures, and that had led to skepticism and slow progress. Terry's (2010) focus was on technical knowledge and lack of technical knowledge as the major reason for slow EHR implementation. Therefore, there is a great opportunity for identification and documentation of major multi-dimensional EHR implementation challenges. That can be achieved by conducting a comprehensive survey of hospitals and healthcare providers. Afterwards, a model for successful implementation of EHR can also be developed.

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It's my iPad! Protecting Critical Data on Personal Mobile Devices in the Medical Setting

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Abstract: The pervasiveness of mobile devices has forced many organizations to support connectivity of corporate and private devices. Corporate devices are highly configurable regarding authentication, encryption, and remote wiping. BlackBerry devices can be fully deployed and managed using a centralized BlackBerry Enterprise Server, however when a user owned device connects to enterprise servers, data security becomes a concern. Introduce a litany of complex legislative rulings and laws concerning protected data across various business domains and now personal mobile devices become security risks. This paper will discuss current issues in securing personal mobile devices in the healthcare environment and present possible solutions.

INTRODUCTION

Mobile devices have been continually increasing their capability for many years. The ability to have a high degree of portability coupled with content creation capabilities and rapid email response are an attractive combination in the medical community. Unlike an institution issued laptop which has robust encryption, complex passwords, and remote administration functionality, mobile devices like Android tablets and iPhones are less mature in the data protection domain. Modern mobile devices include fully standard compliant web browsers which are capable of running applications such as JavaScript and Flash as well as the ability to use content rich email and text editors for document or presentation creation.

Mobile devices also have the additional capability to connect to a cell provider and function wirelessly on those networks. This new functionality provides for a real-time, push data to these devices. The mobile office is no longer limited to instantaneous text messages, but now instant email notification as well as complex collaboration capabilities. This instant connection allows for a more productive and robust workforce, but at the cost of data security.

The iPad can be seen in the hands of various professionals from doctors to executives in the current corporate environment. Often times, this occurs as a bottom up integration into the workplace by consumers and employees instead of the traditional top down corporate leadership driven distribution (Greyer & Felske, 2011). What this

means is that the individual is often seen using their personally owned devices to complete their daily corporate tasks. This in and of itself poses risks to the corporate data assets. For example, many corporations rely on Microsoft Exchange Server for e-mail services. Most mobile devices currently support Microsoft Exchange ActiveSync natively, thus enabling instantaneous push data from the Exchange server. This ability has the potential to transfer protected data to an unsecured device which leaves the organization vulnerable to a myriad of privacy and security laws. It should be noted that push technology creates a data security issue by its very nature. This being the fact that any person in control of a device where push functionality has been enabled can access the data received unless the proper precautions have been enabled on the device.

This paper will present an overview of the usage of mobility in the medical setting, the risks of having protected data on a personal device, security enablement of mobile devices, solutions that will enable the institution to move forward with personal device usage in the corporate setting, concluding with future works.

USAGE OF MOBILITY IN THE MEDICAL SETTING

The usage for mobile devices in the medical setting is vast. Healthcare professionals can stay connected with patient information in a real-time setting. As noted by Prgomet, Georgeiou & Westbrook (2009), mobility can be seen as a central feature of the healthcare delivery system by supporting clinical work, location multiplicity, communication, collaboration and movement between patients without the limitations in a traditional bedside system or desktop device. Mobility is a key driver for all these features. Traditional paper charts are highly mobile, however, accuracy, accessibility and simultaneous access by multiple users are not supported. With the mobile device, not only is mobility supported but also overcomes all of the limiting factors found with the paper based system (Prgomet, Georgeiou & Westbrook, 2009).

To support the effectiveness of the mobile device in the healthcare environment several studies have been conducted between 2000 and 2006 (Prgomet, Georgeiou & Westbrook, 2009). Three studies in the usage of mobile devices in the emergency medicine environment. In these studies, ECGs were transmitted to a desktop computer located at the study site, where ER nurses wirelessly forwarded the images to the cardiologists' PDAs. (Adam et al, 2006; Clemmensen et al, 2005; Reponen et al, 2000). This resulted in a reduction of the median time by about 50% for the door-to-reperfusion time. Similarly, Clemmensen et al found that when the ECGs (electrocardiographs) were transmitted to the desktop and the cardiologist PDA simultaneously, there was a substantial reduction of 54 minutes in the door-to-treatment time (Clemmensen et al, 2005). In the study presented by Reponen et al, (2000), accuracy was measured by assessing the CT image quality. This study found that 86% of the radiology reports from the handheld device were identical to the traditional methods, while 3 of the cases had minor differences which were determined to be of no clinical consequence and 1 case resulted in an additional diagnoses via the handheld that had not been documented by traditional methods (Reopen et al, 2000). There are many other studies that address areas of patient management, medication safety when prescribing via the mobile device, data management and accessibility as well as other areas where there is an overwhelming support for the usage of mobile device within the medical setting (Prgomet, Georgeiou & Westbrook, 2009).

Device Usage

Organizations are still trying to figure out the role of the mobile device within the healthcare organization. A pivotal concern in healthcare is how a mobile device can be integrated into the daily activities of the healthcare professional in a secure and supported fashion. With the usage of mobile devices, the healthcare organization must approach the solutions to this question in a different fashion than has traditionally been implemented when considering a technology addition. Many healthcare professionals are beginning to use their own devices to successfully conduct their daily tasks. While this does encourage the usage of mobile devices in the organizational setting and aids in the completion of various goals (Geyer & Felske, 2011), it poses security risks that the healthcare organization may not be ready to take on. When considering the usage of the personal device, the primary risks posed to the healthcare organization are non-supported user applications from external locations such as Apples App Store and the ability of the healthcare professional to download critical patient data to the personal device during the work. The latter is by far the most significant of the risks posed to the healthcare organization due to the potential exposure or loss of

critical patient data. An in depth look at the protected patient data on a personal mobile device that is used to support the healthcare professional is presented.

RISKS POSED TO PROTECTED PATIENT DATA

The protected patient data when used in the mobile setting that includes the usage of a healthcare professionals' personal device is at risk of exposure by a variety of situations. These include the cohabitation of the patient data along with the user personal data, the risk of data loss by leakage, exposure or breach, and the theft of the device. Additionally, risk is imposed on the healthcare organization when there is the sharing the personal device with unauthorized outsiders such as family members as well as others in medical setting who may not be authorized. One of the most significant and what can be considered to be the most critical security risk comes with the removal of the patient data from the secured medical data store which may result in the risk of complete data exposure to unknown entities.

Cohabitation of Data

Cohabitation, also known as co-mingling, of data occurs when there is usage of a personal mobile device in the healthcare organization. As the healthcare professional moves throughout their day retrieving critical patient data, taking case notes when talking with the patients, prescribing medication as needed, responding to emails and performing subsequent information searches, the information is being stored on the mobile device alongside of whatever internet actions the healthcare provider has performed during their personal time. This could mean that personal financial information is store alongside the healthcare organizational information; Social networking sites may have access to various files that were stored on the mobile device while the healthcare provider was moving throughout their day; there may be comingling of critical emails along with the personal emails. When presented with this situation, it becomes nearly impossible to separate the personal data from the healthcare data and this data may be accessible by many personal applications that have been downloaded by the professional that are not secured. It has been noted on numerous occasions that encryption keys as well as passwords are stored in mobile device applications. While this unsecure method of authentication and authorization does facilitate the end user experience with the mobile device, exposure of the co-mingled data, both personal and professional, is a significant risk to the healthcare organization. As noted by Clarke and Maurushat (2007), the personal device can be considered virtually impossible to impose security regulations on when it comes to what the owner of the device chooses to enable on the device. Given the inability to secure personal mobile devices, co-mingling of data which includes various personal and professional applications opens the device up to vulnerabilities that expose the organization to undue risk (Clarke & Maurushat, 2007).

Loss of Data

Data leakage and breach laws are a relatively new phenomenon, which require companies, in specific instances, to inform the public when personal or private information has been leaked from their authorized channels. Adding to the complexity of securing protected data, data breach laws have been applied in a sectorized approach, each data breach law being applied to specific government and business types. This makes compliance with the law very convoluted (Stevens, 2010; 2006).

Recently data breach laws have moved forward through congress like H.R. 2221, the Data Accountability and Trust Act (DATA). If enacted, this law will require all businesses to notify the FTC if any covered personally data was leaked to unauthorized parties. This bill passed the United States House of Representatives on December 8, 2009 but was not voted on in the senate before the bill was cleared from the docket. This bill or a similar one is likely to re-emerge in the coming years as and will probably be passed (Congressional Budget Office, 2009).

Data leakage and breach law suits are also the subject of extraordinarily high fines. In 2007, TJX, a retail conglomerate owning TJ.Maxx, Marshalls, Winners, HomeGoods, T.K.Maxx, A.J.Wright, and HomeSense were sued for a data breach. TJX was ordered to pay an estimated 256 million dollars for their security failures (Hole &

Netland, 2010). The issue of data leakage and its broad application coupled with high fines for failure to protect data is concerning considering the growth in personal device connectivity. Consider a scenario wherein a private individual, in the employ of a company, connects to the employer's network with a personal electronic device. This is done ostensibly, in order to handle electronic communication more efficiently. This device now contains one or more email attachments which have personal information about the employer's customers. Given that the device has now been exposed to unknown entities, the healthcare organization must now consider the following: In the case of a lost or stolen mobile device, what are the required actions that healthcare organizations take? At what point would the critical data be considered to be breached, and how can the critical data be tracked and recovered across multiple private devices? If the device is being routinely backed up to a server, such as with the Blackberry system, which exists in the cloud, has the critical data been breached? When considering healthcare, data breach laws must be strictly adhered to in order to avoid costly legal battles and the loss of patient-trust in not only the medical facility but also the medical staff. The following sections discuss security implementation techniques to help mitigate the risk of securing private mobile devices connected to the medical facility's infrastructure.

Theft and Misplacement of the Mobile Device

Without the protection of the physical building protecting the mobile device, device theft has an increased risk of probability of occurring given the smaller nature of the device (Ghosh & Swaminatha, 2001). The devices are fairly easy to pick up, conceal and transport in a covert fashion. Often times, when this occurs, the data can be lost forever and is exposed to exploitation by the entity in position of the device. When considering patient information, this leaves the medical facility exposed to repercussion imposed by the various acts and laws in place to protect the patient, as noted above. As Ghosh & Swaminatha note (2001), the lost or misplaced internet enabled mobile device, includes an added risk of allowing the exploiter to access corporate systems including email as well as file systems.

As is commonly understood, the personal mobile device is often shared amongst family members as well as the acquaintances of the owner of the device. In addition, sharing of the personal device that is used in the organizational setting also occurs between professionals regardless of whether that individual has been authorized and authenticated to the information they are given access to. This situation should be considered when the personal mobile device is used in the organizational setting when understanding the security of the personal mobile device. Because the device may contain private critical information, and access to the device may be given in an unsecured manner, the individual in possession may not be authorized to the information the mobile device houses. This creates a condition that can be equated with "theft" or "misplacement" of the mobile device.

The Insider Threat

The insider threat is far more prevalent in the setting where the personal mobile device is allowed to be used as part of the corporate technology stack. This is because the professional using their personal device is afforded the ability to download pertinent patient data to the device and there is no mechanism for its removal before the professional leaves the medical facility. What makes this threat even more covert is that the professional is unaware they are putting the organization at risk simply by leaving the facility with the patient data on their personal devices. As is commonly known, the insider threat poses the greatest risk for organizations (Fonesca, Vieira, & Mederia, 2006). In 2006 the FBI reported in their survey, 52% of the respondents had reported an unauthorized use of information by internal professionals, while 10% of those reporting were unsure if the critical data had been exposed (Fonesca et al, 2008). Given this and the fact that the healthcare professional may not realize the risk they pose by storing and transporting critical data assets the risk of the insider threat grows exponentially.

SECURITY OF PERSONAL MOBILE DEVICES

As previously discussed, the burden of safeguarding the protected data falls on the institution. With traditional PC's network connectivity, many robust solutions exist to ensure proper authentication and encryption capabilities are in place (Duffany, 2007). As technology moves to a more mobile platform, these traditional methodologies may not

always be the optimal solution. Layer into the problem that mobile devices are commonly purchased by individuals and not the institution, as is common with traditional computing platforms, things become more complex. This section will examine the current protection methods available to mobile platforms that can be employed to satisfy Information Assurance concerns.

Authentication

The ability to successfully determine the user accessing the institution's resources has previously been discussed in the literature. Multi-factor authentication using trust based models (Thomas, Menzel, & Meinel, 2008), training users to implement complex passwords and administrative enforcement (Shay et al., 2010), or implementing a two-factor authentication model using third party tools (RSA, 2011) are all traditional techniques for securing data and access to institutional resources. The question that will need to be addressed is will these methods transfer to the mobile domain while ensuring the same level of authentication that is required by mandate or law.

Controlling access to the mobile devices is seen as the first line of defense when securing protected data. To accomplish this, passwords are the most common method (note: smart cards and other two factor authentication techniques that are employed on laptops are presently not supported on the current generation of mobile devices). Another difficult problem is the differentiation between privately purchased and corporate provided devices. Most consumers do not password protect their phones or tablets and institutions should insist on this if protected data resides on the device.

Exchange Server 2010 can be used to push mobile device policies to any user who chooses to use ActiveSync. ActiveSync is the Microsoft technology that enables the communication between any device and the Exchange Server. Currently Apple's iOS, Google's Android, RIM's BlackBerry OS, and Microsoft's Windows Phone 7 all support the ActiveSync protocol. It is important to note that there are minor differences between the implementation of some of the setting in ActiveSync and the various Operating Systems. For example, Apple's iOS has a minimum password of 4 digits while Android devices ignore this setting and configure a default password length of 4. Table 1 contains some of the authentication related settings in ActiveSync and Figure 1 depicts the relationship between the Exchange Server running ActiveSync and the mobile device:

ActiveSync Setting	Description
AllowSimplePassword	Enable use of simple passwords - i.e. abcd or 1234
PasswordRequired	Mandates the use of a password for the device
IdleTimeoutFrequencyValue	Time allowed to enter password
MinPasswordLength	Sets default password length - i.e. 7 characters

Table 1: Mobile device settings in ActiveSync pertaining to authentication.

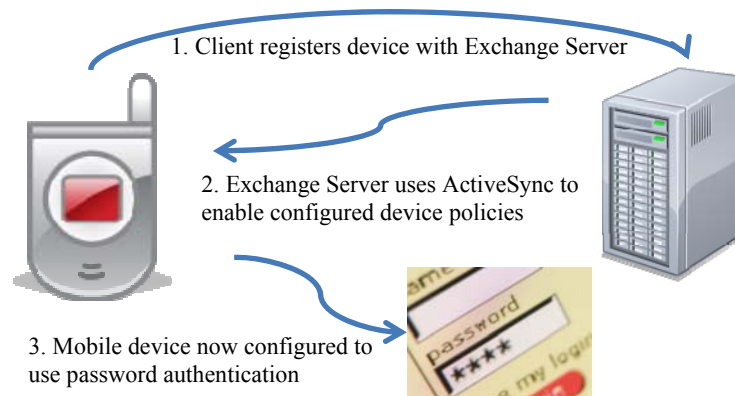


Figure 1: Relationship between mobile device and an Exchange Server.

Across all devices, a *device wipe threshold* can be configured that will automatically wipe the device if the password is entered incorrectly. The purpose of this setting is to limit the amount of brute force or manual password attempts someone could use to gain unauthorized access.

Encryption

PC's that have authentication protection are still vulnerable to physical theft and direct access to user data. A PC's hard drive can be removed and slaved to another machine and the data can be recovered. To combat this, data encryption is used (Snyder, 2006; Symantec, 2011). Mobile devices are no different than PCs, with the exception of mobile devices being easier to misplace, loose, or have stolen. As previously mentioned, many mobile devices are acquired outside of corporate purchasing channels that are being used to connect to company resources. This puts the institution at a crossroad. Does the institution have the ability to force users to encrypt their devices if the users decide to connect to institution resources? Each institution will need to develop an internal version of an acceptable use policy concerning this interaction. Outside of companies' policies, the ability to accomplish device encryption is available across 3 of the 4 major mobile operating systems. Table 2 outlines the type of device encryption by operating system (Android, 2011; Apple, 2011; BlackBerry, 2011; Microsoft_Technet, 2011).

OS	Encryption	Notes
Android	128/256 AES	Minimal support through ActiveSync - varies greatly by OEM (HTC, Motorola, etc). Use of 3rd party software recommended.
BlackBerry	256 AES	Full policy support through BlackBerry Enterprise Solution
iOS	256 AES	Full policy support through ActiveSync
Windows Phone 7	NA	Does not support device encryption

Table 2: Mobile device encryption properties by OS.

Password recovery on the 3 devices that support device encryption also varies. BlackBerry has the most robust solution that is tightly integrated with their BlackBerry Enterprise Server. Administrators have the ability to reset user passwords wireless as well as lockout and securely wipe lost devices. Figure 2 is the BlackBerry Web Desktop Manager that enables a user to control their device wirelessly. Note the "Secure a Lost Device" option.

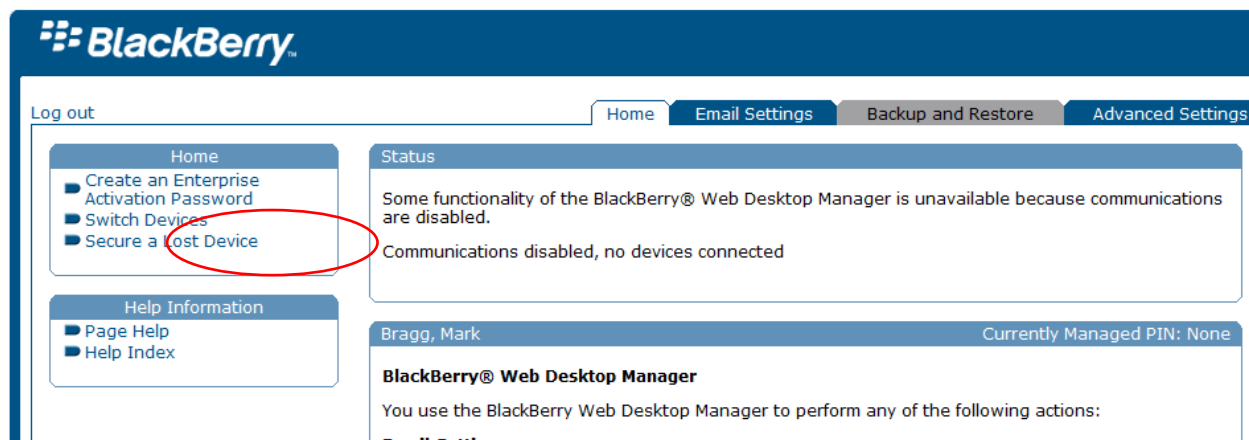


Figure 2. BlackBerry Web Desktop Manager.

Centralized enterprise password management and recovery is not a feature currently supported on either Apple's iOS or Google's Android Operating Systems. This missing enterprise feature may cause institutions problems when providing documentation of security processes for regulators or accrediting bodies. This results in password recovery being left in the hands of the users. All the Technology department can do with a recovered device from an ex-employee is wipe it to a factory state and re-provision it. Additional considerations for digital forensics when using device encryption also need to be considered. If a device is involved in an action that requires further investigation, encryption may cause recovery complications (Barrios & Lehrfeld, 2011).

ENSURING SECURITY ON MOBILE DEVICES

Securing mobile devices using passwords, encryption, ActiveSync, and BlackBerry Enterprise Server aid Technology departments in their task to ensure an institutions data is protected. An all too common problem with the security of mobile devices is their high degree of portability combined with a high loss/thief rate, which in the United Kingdom accounts for half of all street crime and saw a 50% increase in New South Wales (NSW, 2001; Unit, 2011). This loss rate would make remote administration of these devices very important in an enterprise setting. This section will further discuss the capabilities of ActiveSync and BlackBerry Enterprise Server support of remote wipe, the emerging field of contextual aware security settings, and a brief discussion of third party solutions.

Remote Wipe

As demonstrated in the BlackBerry Web Desktop Manager in Figure 2 and Outlook Web Access in Figure 3, both solutions enable end users to remote wipe their devices. According to Microsoft, the remote wipe feature will remove any Microsoft Exchange Server data from the device should the device be lost or need to be re-provisioned ([Microsoft Technet, 2011b](#)). Similar functionality exists with enterprise BlackBerry tools. Windows Phone 7 currently has no support for remote wipe. Windows Phone 7 is currently being marketed to consumers who, presumably, do not have the need for remote wipe capabilities ([Microsoft Technet, 2011a](#)).

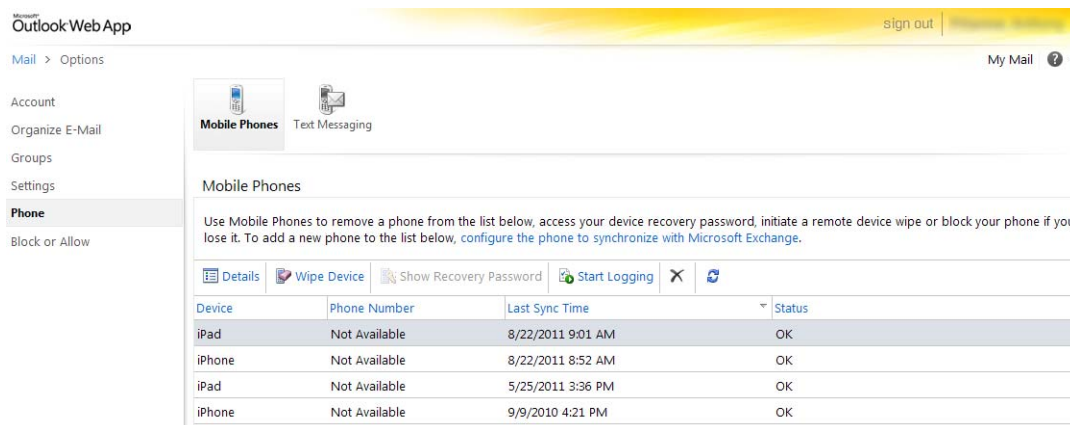


Figure 3: Outlook Web Access interface for remote administration.

Remote wiping varies by OS. Within Apple's iOS, a remote wipe command does not overwrite existing data. Instead it deletes the encryption keys that are used to decrypt the data thus effectively rendering the data inaccessible. With all remote wipe implementations, the device that is being wiped must connect to the remote server to receive the remote wipe command. Should an assailant disable communications on a device using either 'Airplane Mode' or a faraday bag the remote wipe command is never received and the potential for data loss increases. To combat this, as previously discussed in the previous section, a device wipe threshold can be implemented in a device's policy to diminish the success of a brute force password attack. For example, BlackBerry devices default settings allow for 10 password attempts before they trigger a wipe of the device. This functionality further bolsters the security of mobile devices should an incident occur.

Contextual Aware Security

Contextual aware security is not a new concept, rather a concept that is being applied to the ever increasing domain of mobile devices. The premise of context security is the ability of a device to use available information to "characterize the state of an entity" (Wrona & Gomez, 2005). In the mobile device setting, this would include GPS location information, sensed wireless access points currently within range, or resources and applications that are currently being utilized. Previously mentioned was the difficulty that institutions are facing with respect to ownership of mobile devices. Contextual aware security policies have the potential to address some of these concerns. Take the following scenario as an example of the potential uses for contextual aware policies. A user purchases a mobile device and connects to the institutions Exchange Server via ActiveSync. A contextual aware policy is pushed to the device. The policy dictates that a complex password always be used and after 10 incorrect attempts the device is wiped. When the GPS unit discovers that the device is on company property, the policy automatically disables the use of the camera and voice recorder applications. If the device should ever be connected to an unsecured or unknown wireless access point, the policy will establish an encrypted VPN connection to protect transmitted data. All of the enhanced security measures would be enacted without the user having to interact with the device.

Currently there are applications that take a subset of contextual aware information and provide information for users. For example, on iOS devices, a shopping application can query the location services of the device and provide the user with prices for a particular item at stores that are geographically close. Similarly, a movie application can display the current movie times for all local theaters.

CONCLUSIONS

The ability to safeguard the data that an institution maintains maybe legally mandated, needed for accreditation, or just a policy of sound business practices necessitating the securing of mobile devices. The straightforward implementation that has been traditionally implemented on corporate purchased equipment can no longer be assumed

when many of the connected devices are owned by employees. The extent that an institution can force security policies onto private devices relies heavily on the established acceptable use policy and the invasiveness of the settings. The largest perceived security setting for the end user is the logon password. Policies may require authentication every time the device goes into a sleep state. The result is now a user is prompted for a password every time the device is used. Encryption, by itself, is not invasive to the end user but highly sought after to meet legal and policy regulations. Potential issues can come from a user incorrectly entering their password and reaching the device wipe threshold and erasing their device. Alternatively, based upon the OS and device, the ability to perform a remote wipe of a stolen device is very important.

There are still many limitations in securing mobile devices. ActiveSync is not implemented in a standardized way across all mobile Operating Systems. Password recovery is another area where mobile devices lag behind their desktop counterparts. However, there are third party solutions that purport to work as a stopgap where ActiveSync leaves off. For example, Good Technology ([Good, 2011](#)) offers a solution that enhances the remote administration capabilities of mobile devices and allows for password recovery and application deployment.

Future work will include the development of a more robust contextual aware security policy that will remove the end user from concerning themselves with different security settings based upon various contextual situations. Also, the implementation of ActiveSync across the different mobile devices needs to be rigorously examined for policy implementation inconsistencies and a methodology in which to deploy the policies.

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RCQ: Inter-Clinician Relationships, Practice Audit and Communities of Practice for Healthcare Quality Improvement

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Abstract: Inter-clinician relationships and communities of practice have the ability to support continuous quality improvement efforts within healthcare organizations, by offering a means of sharing necessary knowledge that is generally not possessed by clinicians. Sustained adherence to the processes critical to quality improvement is necessary for durable improvements in quality, and knowledge sharing is necessary for supporting these skills, such as practice audit, change management and use of the associated technology. This paper unveils the RCQ (Relationships, Communities, Quality) model, which provides a framework for the purpose of sustaining practice audit for quality improvement in healthcare.

Keywords: practice audit, inter-clinician relationship, relationship-centered care, continuous quality improvement

INTRODUCTION

Improving quality in healthcare remains an ongoing issue. Central to this concern is the need to increase patient safety by eliminating error-prone processes, coupled with pressure to reduce cost and increase productivity. One approach to improving the quality of clinical processes is to do so incrementally, by empowering the knowledgeable frontline workers to make informed changes to workflow. This approach, referred to as Continuous Quality Improvement (CQI), entails the monitoring key process variables and outcomes, so subsequent changes in workflow can be evaluated for effectiveness in improving quality. However, empowering workers and monitoring these variables and outcomes, alone, will not result in quality improvement. Healthcare providers must have the desire, ability and resources necessary to successfully affect change within their practices. Although the ability to change clinical processes is essential, this becomes a significant challenge within complex organizations, and precarious when dealing with human life.

Inter-clinician relationships have the ability to support CQI efforts within healthcare organizations. In this sense, relationships can be defined as a medium for the interchange of knowledge between clinicians. These relationships are connections that clinicians draw upon when knowledge is sought, or new knowledge can be communicated. Communities of practice (COPs) offer a venue in which these relationships can be formed and developed among clinicians. Continuous and sustained adherence to such auditing processes is necessary for durable improvements in quality, and knowledge sharing is necessary for this sustained adherence, as practice audit and CQI require many skills that clinicians do not necessarily possess. Chief among these skills is working with the required technology, which supports the relationship by enhancing the ways in which clinicians communicate.

This paper focuses on the barriers and facilitators of relationships among clinicians for the purpose of sustaining practice audit for quality improvement in healthcare. To accomplish this goal, the need for CQI in healthcare will be presented. Following this, practice audit and its related technologies will be characterized, as well as several challenges in its implementation. Accordingly, a description of inter-clinician relationships as a dimension of relationship-centered care (of which the scope of this paper is largely limited to), and the role COPs play in facilitating those relationships will be discussed. The role of technology will be described, along with its ability to support relationships and enhance communication. The RCQ (Relationships, Communities, Quality) model will then

be posited, which provides a framework for barriers and facilitators for the use of these relationships as media of knowledge sharing, followed by discussion of issues, such as application of the model and future research.

THE NEED FOR CONTINUOUS QUALITY IMPROVEMENT

Clinicians, managers and policymakers are aware of quality deficiencies in the Canadian healthcare system, even though it is a top priority of Health Canada (2004). Preventable adverse events (AEs), which are unintended injuries or complications resulting in harm of a patient, offer an example of this. It has been estimated that, of 185,000 acute care hospital admissions associated with AEs, 70,000 may have been preventable. Also, access to care is not sufficient in rural and remote communities in Canada, which must rely upon traveling physicians and specialists (CTV, 2011). Insufficient emergency room capacity and wait times for surgery have both resulted in occasionally fatal consequences for some (CBC, 2005; 2011; Global Winnipeg, 2009). As well, sociopolitical factors, including disparate geographic administration of medical services, rapidly escalating medical costs and concomitant increasing demands for accountability and transparency in clinical practice, have mandated the development of metrics in performance assessment and mechanisms for promoting perpetual improvement in quality (Harrigan, 2000).

As a fundamental concept, CQI encompasses a philosophy of incessant refinement of an organization's processes, so that they meet or exceed standards of quality established by the consumer (McLaughlin & Kaluzny, 2004a; 2004b; Shortell, Bennett, & Byck, 1998). Also known as "total quality management" (TQM) (Deming, 1986), key to this philosophy are decentralization of control in order to allow frontline workers to leverage accumulated knowledge. It is thought that employees have a natural desire to improve the quality of their processes, as long as organizational leaders create a work environment that encourages them to initiate such changes. Therefore, CQI emphasizes a perpetual effort to incrementally improve quality and the creation of an environment and culture that is conducive to quality improvement in general (Deming 1986/2000; Juran, 1986). Measurement of key variables is necessary in order to generate feedback on performance and create benchmarks based on certain indicators (Powell, 1995). When a change results in a higher level of quality, it is institutionalized, and communicated throughout the work unit.

PRACTICE AUDIT AND ITS BARRIERS

Practice audit (PA) entails the measurement and analysis of clinical work, and the subsequent comparison against a defined standard or benchmark, for the overall purpose of CQI (Godwin, 2001). PA can be described as a phase within a greater cycle of evidence-based practice, where the quality of care is evaluated, after care is applied in practice (Borbasi, Jackson, & Lockwood, 2010). Several cyclical models have been used for PA, for example Plan-Do-Study-Act (Langley, K. M. Nolan, T. W. Nolan, Norman, & Provost, 2009), and Godwin's (2001) fourteen steps. Common among each of these models are perpetual measurement of key indicators, inferring causes of quality issues and theorizing solutions for these problems, implementing change and evaluating performance post-change. In a sense, PA serves the function of detecting the need for change, informing clinicians as to the nature of the change needed, and evaluating the change following implementation. When attending to the needs of patients, one of the goals of being a clinician is to maintain a high enough standard of professionalism by ensuring that one's practice will be of an "acceptable" quality. Thus, it is in the interest of the clinician to have one's care provision iteratively reviewed either by oneself, or through peer assessment, for confirmation of adequate and appropriate service delivery in the maintenance of the highest professional standards. Classical constructs of PA have been professionally driven and directed, with a clear focus on structured peer review processes using clinical practice guidelines and established standards of care (Buetow & Roland, 1999).

For an example of PA, consider the following. A prospective, observational study conducted at a gastrointestinal clinic (Armstrong et al., 2011) described a PA that uses a touchscreen, handheld PC providing point-of-care data collection. Collected data included quality of bowel preparation, and duration of colonoscopy procedure. The audit showed that, compared to the recommended 6 minutes, the procedure was more likely to last longer, and greater than the recommended time, when bowel preparation was less than excellent, as measured by the Ottawa bowel preparation scale (Rostom & Jolicoeur, 2004). This study demonstrated that real-time, point-of-care clinical PDA-administered practice audits in concert with anonymous, peer-comparator outcome data provide a sound foundation for targeted quality improvement interventions in endoscopy.

Implementing PA involves overcoming several barriers, which may either prevent the clinician from either adopting PA or adhering to the tasks and processes associated with PA. In a review of the existing literature, (Johnston, Crombie, Davies, Alder, & Millard, 2000) present a list of barriers and facilitators to PA. Lack of resources, expertise in audit design and planning, organizational dysfunction, and ability to implement changes were identified as barriers to performing PA. Organizational factors, such as leadership and conflict between clinicians and management, have also been identified as affecting the success of PA. Black & Thompson (1993) identifies four categories of barriers for PA by interviewing a group of healthcare professionals. The respondents tended to view PA as merely a formalization of existing tasks. Also, suspicion surrounding PA exists, due to a perception that the government forces PA on unwilling clinicians. As well, the respondents expressed concern for practical considerations, such as lack of time, resources and knowledge of the audit process. The effectiveness of PA in increasing quality of care is questioned, as the audit tasks may not be adhered to in the long run by members of the organization, or changes in clinical processes may be made in order to increase the quality of the audit results, rather than the quality of care. Finally, anxieties surrounding the issue of PA included legal implications, having to share embarrassing results, and costs associated with audit. It is also possible that quality improvement may be achieved through other means, such as opinion leaders (Lomas et al., 1991) or quality circles (Deming, 1986). The feedback must also have the quality of being actionable; it must be to be timely, individualized and non-punitive (Hysong, Best, & Pugh, 2006). Fear that audit results will result in punitive measures or blame is also identified as a negative perception to audit (Kongnyuy & van den Broek, 2008).

INTER-CLINICIAN RELATIONSHIPS AND COMMUNITIES OF PRACTICE

The relationship centered-care (RCC) approach (Tresolini et al., 1994) differs from previous concepts of care that considered only the disease and its direct physiological effects on the human body. RCC recognizes the individualized interpretation of disease as being unique to each person, as well as the influence of these experiences on the lives and communities of patients (Frankel, Quill, & McDaniel, 2003). As patients heal, these psychosocial factors are to be considered along with the biological. This approach proposes that relationships are central to effective and satisfying healthcare delivery. It is through these relationships that emotional connections and genuine caring for others can be developed, and the psychological and social factors truly understood by the clinician. Good relationships among members of the healthcare system are the mechanisms for the exchange of complex information and emotions, if not therapeutic and satisfying in itself (Beach & Inui, 2006; Frankel & Inui, 2006).

Inter-clinician relationships, one dimension of RCC, are important to the development of PA in healthcare. Relationships are manifested through knowledge sharing, collaboration, co-operation, learning from other disciplines and mutual support (Beach & Inui, 2006; Tresolini et al., 1994). In this context, each clinician has an intrinsic desire to contribute their unique perspectives and experiences with clinicians, while in pursuit of their own quest for higher quality care. A community comprising clinicians with this common interest serves as a medium in which relationships are developed and sustained (Wenger, McDermott, & Snyder, 2002). Communities of practice (COPs) are characterized by a domain of interest to all its members, the tendency for its members to engage in assorted activities pertaining to the sharing of knowledge, and the development of a practice-specific knowledge base, which can be drawn upon and contributed to by its members (Wenger, 2000). In the context of PA, a community may define their domain of interest around certain medical specialties, quality indicators or healthcare organizations, which may have their own suite of tools, technologies, techniques to conduct, interpret and act upon the results of PA. Consequently, all members will have a degree of interest in sharing and contributing knowledge pertaining to the domain respective of each community. Membership of these communities, therefore, is not necessarily limited by factors such as organizational boundaries, profession, skill level or industry, for example. Although this concept is not without criticism (eg. Amin & Roberts, 2008), it is still lauded as a viable concept for quality improvement in healthcare (Fung-Kee-Fung et al., 2009; Lashoher & Pronovost, 2010).

THE ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGY

If we consider that the role of information and communication technologies (ICTs) in CQI is to facilitate knowledge exchange via relationships, this creates a unique orientation to the discussion. ICTs first and foremost enable members of communities of practice to communicate over geographic and temporal barriers (Ardichvili, Page, &

Wentling, 2003; Cox, 2008; von Krogh, 2002). These “virtual” COPs - or, more accurately, “hybrid” COPs, as COPs do not necessarily have to limit themselves to any one form of communication (Amin & Roberts, 2008) - exist as online forums, email, listservs, social networking sites and such. However, ICTs can *enhance* communication between members of a community, to facilitate the communication of highly contextualized information and knowledge. First, the ability to create graphical models of clinical processes would allow clinicians to easily communicate clinical process designs to other clinicians, researchers and technologists. This benefit will allow the transmission of highly specialized and contextualized information, in a way that all members of the COP can understand. Although process modeling has not been widely applied within healthcare to this end, some research shows that clinicians prefer certain modeling techniques over others (Jun, Ward, Z. Morris, & Clarkson, 2009). Second, centralized data storage and effective graphical interfaces can enable communication of actual performance results, so that they may be compared, critiqued or combined among members (Rees & Dineschandra, 2005). The amount of data collected by an audit can possibly be immense, especially if you consider the aggregate of many clinicians’ audit efforts. Using cloud computing services, (Armbrust et al., 2010), distributed data mining services can consolidate data stores in order to derive knowledge from the audit data, of many clinicians, for an even wider audience (Talia & Trunfio, 2010). Third, anonymous and secure web portals may encourage clinicians to share information that may be condemning or embarrassing. In instances where such serious quality issues may exist, the clinician may be able to benefit from sharing this information, yet may not want to be identified (Gallagher, Waterman, Ebers, Fraser, & Levinson, 2003; Mazor, Simon, & Gurwitz, 2011). This is relevant to audits that require peer-comparator judging (Hamburg, 2010; Webster-Wright, 2009). This method of data analysis entails uploading of audit data to a central, secure web site, where it is evaluated and scrutinized by peer clinicians, securely and anonymously. This method is especially useful when data is captured in image form (Armstrong et al., 2006).

Successful adoption of the required technology entails its acceptance by its intended users (F. D. Davis, 1989; Venkatesh, M. G. Morris, G. B. Davis, & F. D. Davis, 2003). The Technology Acceptance Model (TAM) posits that the perceived ease of use and perceived usefulness are determinants of the user’s intention to use technology, and its subsequent use (F. D. Davis, Bagozzi, & Warshaw, 1989). More recently, development has focused on determinants of each of the perspectives in order so that research using this model can produce a more actionable outcome (Venkatesh & Bala, 2008). With this purpose in mind, interventions can be constructed, administered and evaluated for the purpose of increasing user acceptance. Perceived usefulness of the technology is determined by subjective norms, image, job relevance and result demonstrability. Subjective norm refers to the degree to which individuals that are important to the user view the technology as important to use. Image pertains to the degree to which users believe that use of the system will increase their social status within a social system. Job relevance refers to the belief that the system is applicable to the user’s job. Output quality, a moderator of job relevance, pertains to the perception of how well a system performs the tasks relevant to the job. Result demonstrability refers to the tangibility, observability and communicability of the results, as perceived by the user. Perceived ease of use is immediately determined by the user’s degrees of computer self-efficacy, to which support is perceived as available, to which anxiety is felt at the prospect of having to use technology, and to which the user uses technology spontaneously and “playfully”. After some time of use with the technology, perceived ease of use is adjusted by the objective usability of the technology and the perceived enjoyment received while using the technology.

RCQ – RELATIONSHIPS, COMMUNITIES, QUALITY

Drawing upon several theories, a framework for barriers and facilitators to relationship building through communities, for the purpose of CQI, can be proposed. Specifically, this framework includes barriers and facilitators to clinicians using communities of practice to both contribute and draw knowledge from COP, two actions that will dictate the supply and demand of knowledge in the community. Facilitators and barriers are further split into qualities of the person, environment and the COP itself. Personal qualities include perceptions, desires, and other traits that affect an individual’s participation. The environmental qualities encompass traits of the individual’s organization, profession, social environment and culture. The RCQ framework is detailed in Table 1 (below). This framework can be used to maximize the benefits of relationships in quality improvement endeavors that involve practice audit.

	Facilitators			Barriers		
	Personal	COP	Environment	Personal	COP	Environment
Contribute	<ul style="list-style-type: none"> - View of knowledge as a public good¹ - Feelings of obligation¹ - Desire to develop professionally¹ 	<ul style="list-style-type: none"> - Connect with experts¹ - Demonstrated value^{1,9} 	<ul style="list-style-type: none"> - Facilitation⁹ - Cultural values¹ 	<ul style="list-style-type: none"> - Desire to protect knowledge¹ - Fear of exposure^{1,7} - Fear of misinforming¹ - Feelings of unworthiness^{1,1,4,8} - Acceptance of technology^{2,8} - Lack of expertise¹⁰ - Lack of resources^{10,12} 	<ul style="list-style-type: none"> - Dysfunctional norms⁹ 	<ul style="list-style-type: none"> - Desire to protect knowledge¹ - Forced upon^{3,10}
Draw	<ul style="list-style-type: none"> - Desire to keep informed and up to date¹ 	<ul style="list-style-type: none"> - Access to resources¹ - Demonstrated value^{1,9} 	<ul style="list-style-type: none"> - Facilitation⁹ - Cultural values¹ 	<ul style="list-style-type: none"> - Low actionability of PA results¹ - Hard-to-duplicate problems¹ - Effectiveness questioned¹¹ 	<ul style="list-style-type: none"> - Dysfunctional norms⁹ 	<ul style="list-style-type: none"> - Availability of competing communities¹

Table 1: The RCQ framework. This framework presents factors that act as barriers and facilitators to contributing and drawing knowledge from communities of practice, for the purpose of practice audit and quality improvement. These factors can be personal traits, exist as features of the community itself, or of the environment in which the individual and community exists. 1: (Ardichvili et al., 2003). 2: (Venkatesh & Bala, 2008). 3: (Jamtvedt, Young, Kristoffersen, O'Brien, & Oxman, 2007). 4: (Hysong et al., 2006). 5: (Gallagher et al., 2003). 6: (Mazor et al., 2011). 7: (Kongnyuy & van den Broek, 2008), 8: (Nicolini, Powell, Conville, & Martinez-Solano, 2008). 9: (Wenger et al., 2002). 10: (Johnston et al., 2000). 11: (Black & Thompson, 1993). 12: (Lomas et al., 1991)

Central to personal reasons to participate in a community is the view that knowledge is a public good, and should be freely shared. Also feelings of obligation to an organization, community or for moral reasons may compel an individual to contribute. As well, one may want to develop oneself in a community by establishing themselves as a researcher, or mentoring others. Drawing knowledge from the COP is seen as a good way to keep informed about events, developments in the community. Personal barriers for contribution include the desire to protect knowledge, partly due to the view of knowledge as a personal resource. A person may be unwilling to participate, because they feel they may be ridiculed for their knowledge or opinion, identified as incompetent or blamed for certain issues. Also, a person may not want to participate because they fear that they will be misinforming others with their knowledge. Feelings from unworthiness stem from the view that they have not “earned the right” to contribute, and the technology and software associated with audits may not be acceptable by the individual, which compromises their ability to use enhanced communication methods. Lack of expertise of the clinician, or resources to perform audit, can also act as a barrier. Low actionability of PA results and questioning effectiveness of PA could possibly hinder further CQI efforts, and a resultant draw of knowledge. Hard to duplicate problems may discourage a clinician from using a COP because they feel that it would be unlikely that anybody could offer valuable contribution.

The qualities of the COP itself affect the volume of knowledge sharing over relationships. Access to experts, so that relationships may be created with them encourages contribution. A COP that can demonstrate its value and usefulness will encourage activity. Access to desired knowledge resources and availability of experts also make a COP appealing. Dysfunctional norms within the community, such as in-fighting, cliquishness, and the tolerance of belittling will reduce the appeal of the community. Environmental factors, such as a cultural norm that encourages participation in COPs, and the right facilitation and resources from organizational sources, facilitate participation in COPs. If environmental factors encourage the protection of knowledge, or force participation in a COP, this can actually have a detrimental effect on the rate of contributions. The availability of competing or rival COPs can also affect the demand side.

CONCLUSION AND FUTURE RESEARCH DIRECTION

This paper illustrates the importance of inter-clinician relationships, as a resource for adopting and adhering to practice audit activities, with the overall purpose of quality improvement of clinical processes. As increasing quality of healthcare processes is an ongoing issue, practice audit presents a viable solution for detecting quality issues in care processes. Along with practice audit, inter-clinician relationships are an important resource in which information, knowledge and support for these activities can be found. The roles of technology in supporting these

relationships include overcoming geographical and temporal barriers, as well as enhancing the communication between clinicians.

The grand vision of this research path is to accumulate and consolidate knowledge on practice audit, applied to improve patient clinical outcomes, patient safety and satisfaction for all actors in healthcare. Currently, there is sparse research as to the role of inter-clinician relationships within continuous quality improvement with practice audit. A validated RCQ framework will allow practitioners to explore the benefits that relationships afford to their respective quality improvement efforts. Further, results of this study will assist clinical decision makers and policymakers in configuring resources in order to maximize chances of successful adoption of quality improvement initiatives.

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Effect of Practitioner Self Care and Anxiety on Relationships within the Context of Organizational Change

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Abstract: The purpose of this research paper is to review the literature and suggest the relationships between organizational change through implementation of new health information technology (HIT) and/or reconfiguration of existing HIT, practitioner anxiety, and effective caring practitioner/patient and practitioner/practitioner relationships using a conceptual framework of Relationship Centered Care (RCC). Engaging in frequent and regular self-care interventions has been shown to be related to practitioner/patient caring ability and caring efficacy. According to a published model of RCC, it may be anticipated that self-care may decrease practitioner anxiety in the context of organizational change and increase ability of the practitioner to engage in effective caring relationships with patients and other practitioners. Through the lens of RCC and within the context of organizational changes such as implementing HIT, a conceptual model for research is proposed, research questions and hypotheses are stated, and methodology for a future stream of research is briefly discussed.

INTRODUCTION

Relationships between individuals and their healthcare practitioners are of vital importance. They provide the means for exchange of communication, sharing of feelings, emotions, and concerns, and are at the core of human needs (Manning-Walsh, Wagenfeld-Heintz, Asmus, et al., 2004). It is within the connectedness of relationships that meaning and purpose in life are derived. Healthcare practitioners often find satisfaction and gratification from relationships that they establish with patients (Lampe & Snyder, 2008). Effective relationships among practitioners in healthcare are essential to attend fully to the multiple factors that affect healthcare delivery and healthcare outcomes such as exchanging information, allocating resources, arriving at a correct diagnosis, choosing treatments and interventions, and evaluating outcomes of care (Beach & Inui, 2006).

There is an expansive body of literature that covers at least five decades which defines caring as an ontological perspective of being (Watson & Smith, 2002). Caring is a manifestation of being in the world and interacting with others rather than a set of tasks and skills that require knowledge, ongoing exploration, and learning (Watson, 2008). There has long been a focus on the primacy of relationships within caring nursing practice. Caring is more than a behavioral, technical or mechanistic approach to delivering healthcare, it focuses attention on a holistic approach which includes the mind, body, and spirit of the self and the other in a relationship (Manning-Walsh, Wagenfeld-Heintz, Asmus, et al., 2004). While caring is an essential human attribute and should be a total way of being for the practitioner, it remains an elusive construct to measure. RCC moves caring one step beyond essential human attribute and emphasizes the importance of relating and interacting among individuals as essential to therapeutic healing activities regardless of healthcare setting or discipline. Healing happens when caring relationships between practitioners and patients are encouraged, developed, and nurtured.

Nursing has a long history of emphasizing caring in relationships with patients, families, and with other healthcare practitioners and it has long been asserted that caring heals (Johnson, 2012). However, it has only been in the recent decade and a half that caring has become a core concept in other healthcare disciplines. For more than a century the biomedical model was the predominant paradigm that defined healthcare delivery and education (Tresolini & Shugars, 1994). This model has a narrow focus on illness and curing. During the 1980s there was a shift in the United States political structure which resulted in an even greater de-emphasis of caring and relationship building because of an increased emphasis on economic and business aspects of healthcare. Changes in healthcare financing at the national level placed undue attention on the "bottom line" at the expense of caring and relationship building in healthcare delivery.

Recognizing a need to address the interdependence of psychological, social, and biological factors that contribute to health and illness, and to identify issues vital to education of a wide range of healthcare practitioners, two distinguished groups of researchers, educators and practitioners (Fetzer Institute and Pew Health Professions Commission) formed a taskforce which explored new possibilities and new concepts related to, and necessary for, a shift to a new paradigm for healthcare (Tresolini & the Pew-Fetzer Task Force, 1994). The goal of this collaborative effort was to broaden understanding of how educational programs could help students of various disciplines learn and apply an integrated approach to healthcare. Among the landmark results of this collaborative taskforce was the introduction of the concept of relationship centered care. RCC is contextual and includes non-hierarchical relationships between practitioner and patient, practitioner and practitioner across multiple disciplines, and practitioners and the communities in which they practice. Within RCC, healthcare is delivered in such a way that humanism is advanced, relationships are valued and attended to, the patient's subjective or lived experience of health and illness is valued, and a holistic approach of tending to the mind, body, and spirit is embraced (Suchman, 2006). A hallmark of RCC is that it moves the emphasis within healthcare delivery away from the medical model of illness and cure and the business model of technology and technical skills to an emphasis on relationships. Major emphasis is placed on the importance of relationships in improving or maintaining health and well-being or supporting and enhancing the dying process. RCC is a vital concept and a primary complement to healthcare efforts of curing illness, promoting patient healing, improving quality outcome measures, and reducing cost. It is the glue of the practitioner/patient relationship and may be a necessary component for teaching people to care for their own health (Lampe & Snyder, 2008). Through the lens of RCC emerges a progression that takes an individual from self-awareness to recognition of the need for self-care which ultimately enhances practitioner/patient relationships. There is need for research validating this progression, examining the same progression for practitioner/practitioner relationships, as well moving one step further and examining RCC's relationship to organizational outcomes and patient healing.

A small group of community leaders, healthcare providers, and educators in SW Michigan developed a network in the late 1990s to explore implementation of RCC within healthcare and to evaluate how effectively it was being taught to healthcare disciplines in that area. Upon recognizing a need to further explicate and make operational, for the purposes of teaching and research, the work of Tresolini and the Pew- Fetzer Task Force (1994), this small group of professionals met monthly or oftener for over two years to develop a conceptual model of RCC that would be useful for healthcare practice, healthcare education across disciplines, and research. The Relationship Centered Care: The Expanding Cup Model (Manning-Walsh, Wagenfeld-Heintz, Asmus, et al., 2004) was the product of the group and it was subsequently published and presented at international conferences. Concepts within the model include self (including self-awareness as an individual and self in relationship with others), reciprocal learning (allowing the patient to be the expert teacher about his/her own life story and understanding of his/her individual meaning of health and/or illness), mutuality (the working phase of the relationship in which the practitioner and other co-create a desired reality), and transformed relational capacity (not the end of personal or relational growth rather a trigger for new cycles of expanding RCC capacity when establishing new relationships). The schematic of the model (Manning-Walsh, Wagenfeld-Heintz, Asmus, et al.,) suggests progression through the phases of the relationship, beginning with self and moving towards transformed relational capacity, which becomes circular in nature as practitioners become changed by relationships and capacity for subsequent relationships is expanded. While this RCC model is used as the conceptual framework for nursing care delivery in at least two health care systems in SW Michigan and the concepts of the RCC model have been incorporated into the philosophy and mission of at least one baccalaureate and master's level school of nursing in the area, little research has been done to validate the relationships among the concepts in the model.

LITERATURE REVIEW

Relationship Centered Care

Self, including self-awareness, is at the center of the RCC: Expanding Cup model (Manning-Walsh, Wagenfeld-Heintz, Asmus, et al., 2004) and self-care interventions initiated in response to needs identified through increased self-awareness may be essential to the practitioner's ability to engage in effective therapeutic relationships with patients as well as other practitioners. By the phrase "self-awareness", the author means awareness of self alone and in relationship to others. There appears to be interconnectedness between the practitioner's relationship with self,

and his/her relationship with patients and families, and with colleagues (Johnson, 2012). The practitioner's relationship to his/her own self may be the least explored concept of RCC. Working to improve the health of another requires "resourcefulness and resilience on the part of the [practitioner] that has its deepest roots in the practitioner's right relationship with self and self well-being" (Beach & Inui, 2006, p. S7). To date there has been one study conducted specifically to validate the RCC: Expanding Cup model. In a study of 75 registered nurses working in a rural hospital in SW Michigan, there was a strong positive relationship between overall self-care and perceived caring ability ($r=.647, p<0.001$) (Manning-Walsh, 2011, unpublished manuscript). Additionally, there was a moderate positive relationship between the nurses engaging in self-care and perceived relational efficacy with patients ($r=.329, p<0.01$). In other words, the nurses who scored higher on a measure of self-care related to measures of health perceived themselves better able to develop caring relationships with patients. They also perceived that their relationships were more effective in achieving positive patient outcomes.

In a study (Stark, Manning-Walsh, & Vliem, 2005) using a longitudinal single group design, nursing students had a significant increase in self-care activities for at least one year after completing a course in which they were taught multiple holistic and complementary interventions and in which they developed and followed a self-care plan for one semester. The care plan that the students developed included, by course requirement, holistic modality interventions to improve the students' health in areas that were self-identified by the students to be areas of actual or potential need. In a questionnaire administered one year after completion of the course, the scores on measures of health remained statistically higher than baseline scores. These findings suggested that nursing students can and do increase self-care when given time to develop self-care interventions as a component of a nursing course and that they maintain higher than baseline levels of well-being for at least one year following implementation of the self-care plan. One might speculate that these findings may also be true for registered nurses in practice however, that is not currently known.

Self-care precedes effective caring relationships among practitioners as well according to the RCC: Expanding Cup model. Yet little is found in the literature that examines practitioner/practitioner relationships (Safran, Miller, & Beckman, 2006) especially as they relate to patient and organizational outcomes. Nonetheless, practitioner/practitioner relationships may well be foundational to organizational functioning and patient outcomes. Available evidence suggests that effective practitioner/practitioner relationships may offer the potential for breakthroughs in organizational performance, improved quality of life for healthcare practitioners, and improved measures of patient outcomes and patient healing (Safran, Miller, & Beckman). However, new knowledge about the antecedents of effective practitioner/practitioner and practitioner/patients relationships is lacking and needs to be generated through research. Additionally, the RCC: Expanding Cup Model needs to be validated as a useful conceptual framework for research and practice. To that end, a model demonstrating proposed relationships between self-care and practitioner/patient and practitioner/practitioner relationships within the context of organizational change and the anticipated effect it has on practitioner anxiety is proposed (see Figure 1). Following a review of the literature on changes in organizational HIT and the effect those changes may have on practitioner anxiety, research questions and hypotheses emanating from the proposed model will be stated.

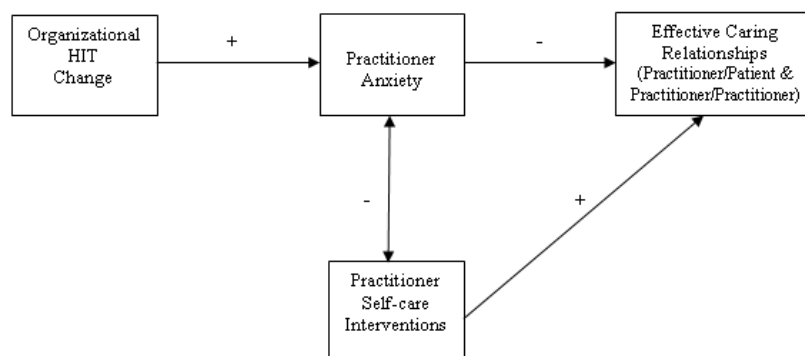


Figure 1: Relationships among Conceptual Concepts of RCC and Organizational Change

Changes in Organizational HIT

Many changes in healthcare are related in some way to HIT. Healthcare is in the midst of an information explosion (Lorenzi & Riley, 2003). National efforts in the U.S. are aimed at improving healthcare quality including streamlining and sharing of health information through interconnected HIT systems. The use of electronic health records (EHR), one form of expanding HIT, has increased in the United States from use in predominantly large academic medical centers to community-based health care services and outpatient settings in the past decade (Kossman & Scheidenhelm, 2008). Research is needed to better understand the effect of increasing use of information technology on the practice of nursing as well as on other disciplines and on levels of anxiety of practitioners who are the users of HIT. There is insufficient knowledge about the use of EHR/HIT and how it affects not only the work flow of the practitioner, but how it affects practitioner anxiety, patient care outcomes, and practitioner relationships as well.

The Diagnostic and Statistical Manual of Mental Disorders of the American Psychiatric Association, better known as DSM IV, describes anxiety as a mood state in which the individual experiences fear, apprehension, nervousness, worry, and/or tension (Beckers, Wicherts, & Schmidt, 2007). There is a body of literature over the past three decades that examines a phenomenon labeled computer anxiety. Computer anxiety, by definition, is linked to the actual or symbolic presence of a computer and is manifested by a sense of computer illiteracy, lack of self-efficacy, heightened physical arousal in the presence of or at the thought of computers, feelings of dislike of computers, interruption in self-confidence, and negative beliefs about the role of computers in everyday life. While validity studies on computer anxiety have shown it to be a robust phenomenon, there is no consensus on whether computer anxiety is situational (state anxiety) or a characteristic of the individual's personality (trait anxiety) or a combination of both state and trait anxiety. Computer anxiety may contain an existential component related to the conception of self which may force individuals to radically rethink their beliefs and values resulting in a conclusion that alters meaning and purpose in life (Beckers, Wicherts, & Schmidt). When meaning and purpose are disrupted, spiritual and emotional distress may result (Manning-Walsh, 2005) requiring the individual to re-evaluate self awareness which may ultimately affect the individual's ability to engage in effective caring relationships with others.

While new technology may enhance nursing practice, it may also have negative aspects that increase anxiety for practitioners (Kossman & Scheidenhelm, 2008; Zuzelo, Gettis, Hansell, & Thomas, 2008). Among the perceived negatives are increased time spent retrieving or documenting information, decreased time spent with the patient, decreased practitioner/practitioner communication, and decreased critical thinking. Some nurses have reported spending an average of 50% of their work time using EHRs (Kossman & Scheidenhelm) and perceived that in addition to being time consuming, the EHR had negative effects on nursing work. While positives are generally reported to be greater than negatives, the problems encountered add to the frustration and anxiety of the practitioner using HIT. While the use of an EHR may improve patient safety, quality of care may suffer because of the amount of time that the practitioner must spend with the EHR. Some studies reported that when physicians and physician assistants were not proficient in retrieving information from the EHR, they would turn to nurses to retrieve the information adding to the workload and anxiety of the nurse. Having multiple practitioners competing for a limited number of computer stations also increased practitioner anxiety (Lee, 2007). Additional research is needed to more clearly elucidate the effect of EHR/HIT on patient outcomes, practitioner anxiety, and relationships between practitioners/patients and practitioners/practitioners.

Because of inherent instability in the business environment (Bloodgood & Salisbury, 2001), frequent changes in healthcare reimbursement, and the U.S. national Health Care Reform Bill of 2010, healthcare organizations may find themselves forced to change the ways they manage healthcare information. Bloodgood and Salisbury suggest four categories of change interventions related to HIT; a) reconfiguring existing resources, b) acquiring and reconfiguring resources, c) acquiring resources without configuring, and d) doing business as usual. These interventions might help practitioners and researchers understand and explicate the relationship between the emergence and acquisition of changes in HIT management within a healthcare organization along with the adequacy and efficacy of practitioner/patient and practitioner/practitioner relationships. One might logically assume that doing business as usual, in terms of the effects of change, would create the least anxiety for practitioners in the healthcare workplace. Acquiring resources with or without reconfiguring, as in the purchase and implementation of a new HIT package or system, would require considerable acquisition of explicit knowledge by the practitioner users which would likely result in increased anxiety while practitioners were on the steep slope of a learning curve. On the other hand, reconfiguring existing resources allows the practitioners to use existing tacit knowledge while learning new

applications for the existing system thus reducing the incidence of increased anxiety. Existing routines might be able to continue with reconfigured resources rather than implementation of newly acquired resources. While experts in HIT are comfortable with explicit knowledge because it is more easily handled by IT (Bloodgood & Salisbury), much of the knowledge that healthcare practitioners (i.e. nurses and physicians) manage on a daily basis is tacit knowledge. The need to manage predominantly tacit knowledge as explicit knowledge can lead to increased anxiety for the practitioner who is forced to learn a newly acquired or re-configured technology system and is pushed into using predominantly check boxes to replace narrative documentation.

In a study that examined the effect of a workplace stress reduction program utilizing positive emotion refocusing and emotional restructuring techniques, McCraty, Atkinson, and Tomasine (2003) found that compared to the control group, the study group of 38 hypertensive employees demonstrated reduction in systolic blood pressure and improvement in emotional health. The improved emotional health included reductions in stress symptoms, depression, and global psychological distress and significant increases in peacefulness and positive outlook leading to decreased anxiety. The study group also demonstrated increased work-place satisfaction and value of personal contribution to the organizational work. Employee (practitioner) emotional well-being has been identified as one important determinant of organizational health, performance, and productivity. High level of emotional distress is among the most costly health problems to employers resulting in absenteeism, disability, and failure to meet productivity standards while positive emotions and psychological well-being have been linked to numerous organizationally relevant benefits including job performance, job achievement, and job satisfaction (McCraty, Atkinson, & Tomasine).

Dealing with change is one of the most difficult problems healthcare organizations face (Lorenzi & Riley, 2003). Implementing major HIT changes is challenging and many healthcare organizations have had some type of “failure” in the roll-out of new information systems. While the “failure” may not be the entire HIT system, it may result in spending huge amounts of money and frustrating countless people in the efforts of implementation. Although installing the hardware and software components of healthcare systems is a huge task, installation does not equate with implementation. People are required to use the systems and need sufficient training and support. When organizations fail to recognize these aspects, practitioner issues such as anxiety may become magnified. When evaluating the cost to the organization of a new or reconfigured HIT system, intangibles such as stress on the organization and anxiety for the practitioners involved must be taken into consideration. Dix, Steggle, Baptiste, and Risdon, (2008) suggest that sustainable organizational change, such as changes in HIT, will only occur if behaviors of healthcare practitioners change. “In today’s rapidly changing environment, the ability to change rapidly, efficiently, and almost continually” (Lorenzi & Riley, p. 197) creates dilemmas for organizations and challenges for individual practitioners. There is a dearth of literature examining practitioners’ perspectives over time related to use of HIT. Such variables as age, organizational role, length of organizational employment, prior and frequency of computer use may be predictive of willingness to change, perceived ease of use and overall usefulness of HIT, and amount of practitioner anxiety when new HIT is introduced and implemented (Kossmann & Scheidenhelm, 2008; Seckman, Romano, Mills, Friedmann, & Johantgen, 2009).

Managing the effects of change involved in HIT systems and upgrades should start early in the technical and planning process (Zuzelo et al, 2008). “Change management is the process of assisting individuals and organizations in passing from an old way of doing things to a new way of doing things” (Lorenzi & Riley, 2003, p. 200). It involves understanding the culture of the healthcare organization and determining if it is stable or whether there are cultural changes already occurring. Change resistance may be lessened if there is already a low level of pressure and stress within the organization. Many technically sound applications have failed as a result of sabotage by practitioners who resisted change because they liked the old ways in which things were done. The cost of successfully anticipating increased anxiety, implementing interventions to manage practitioner anxiety through increased practitioner self-care, and managing change may be expensive in terms of time and energy, but would be less costly in the long run than that of an expensive HIT system that never gains real practitioner acceptance or of disrupted practitioner/patient or practitioner/practitioner relationships that result in negative organizational and/or patient outcomes. Understanding the relationship between HIT system change, practitioner anxiety, and the effect on caring relationships is crucial for managing change while maintaining effective caring practitioner/patient and practitioner/practitioner relationships.

Research Hypotheses and Questions

1. Ho: There is a positive relationship between practitioner self-care interventions and effective caring practitioner/patient relationships.
2. Is there a positive relationship between practitioner self-care interventions and effective caring practitioner/practitioner relationships?
3. Is there an inverse relationship between practitioner self-care interventions and practitioner anxiety?
4. Do practitioners who have increased anxiety engage in more self-care interventions to reduce that anxiety?
5. Is there an inverse relationship between ongoing changes in HIT and practitioner anxiety?
6. Is there an inverse relationship between increased practitioner anxiety and effective caring practitioner/patient relationships?
7. Is there an inverse relationship between increased practitioner anxiety and effective caring practitioner/practitioner relationships?

While not part of the conceptual model of this research paper, additional streams of research might also examine the relationships among study variables when patient self-care is added to the model as well as both state and trait anxiety experienced by the patient. Future studies might well examine caring relationships from the perspective of the patient as well as the practitioner.

METHODS

Knowledge discovery about the relationships that exist between the concepts introduced in this author's writing can be accomplished in several ways. A survey can be developed to test the relationships discussed herein, as well as direct observations of practitioners in environments where systems are being implemented and used. Of particular interest is a longitudinal approach that may show the modulation of anxiety, relationships, and caring over time. Data on demographic characteristics that may have an effect on the degree to which an individual engages in self-care and to describe study participants is deemed important to understand the nature of the concepts discussed. Following Institutional Review Board approval, participants will be recruited from healthcare organizations that will be implementing HIT change within the organization. Data will be analyzed using the appropriate statistics and published.

CONCLUSION AND FUTURE DIRECTIONS

This paper reviewed some of the emergent issues that originate from the influx of technology, EHRs, and the people who use them. Central to this case is that caring should not be compromised because of the use of technologies that are intended to improve care. There are many opportunities that exist to inform the healthcare and technology communities about what happens in health care organizations when technologies are used, particularly at the patient and practitioner level. This research is in high demand and will continue to grow over the next decade.

In the future, the concepts brought forward here will also need to be explored in terms of family members and their caregivers because technology is increasingly encroaching into their personal space. At this time, there is little direct research on the effects of technology on family relationships. Additionally, as the use of technology increases, so does the ability of patients and family members to acquire information. It is likely that the fundamental power that patients and caregivers have in relationship to the health care providers is likely to shift. It will be important to understand the shifts in power and the expectations of patients and their health care providers in an enlightened environment.

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The Social Networking Adoption Matrix (SAM) Prototype: Helping Healthcare Organizations Effectively Choose Social Networking Technologies

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Abstract: Healthcare organizations looking to increase communication and educational offerings to their community, providers, and healthcare consumers need to implement social networking technologies. However, without a thorough needs analysis a healthcare organization may waste valuable limited resources with very little return on investment. In this paper, the authors discuss preliminary research targeted to help organizations adopt relevant technologies using a Social Networking Adoption Matrix (SAM). SAM helps organizations decide which social networking technology categories are necessary to meet their strategic goals via the Social Network Adoption Matrix Expert System (SAMES). As a result, organizations can successfully increase communication opportunities and balance the necessary resource investment.

KEYWORDS

Social Networking, Technology Adoption Model, Decision Matrix, Expert Systems

INTRODUCTION

On most days one can read a newspaper, turn on the television, or read a blog posting that discusses the constant struggle of non-profit organizations to meet its constituents' needs (O'Connell, 2010). Many healthcare organizations fall into this category as well (Eysenbach, 2008; Boulos and Wheeler, 2007). Whether it is a lack of resources, staffing issues, or other internal dynamics, an organization needs to fulfill its mission; most organizations must still

find ways to keep people informed and engaged in their own personal healthcare or the organization's mission and goals.

In the past, many organizations used a combination of print newsletters transformed into static websites, and e-mail distribution lists would deliver and remind people of the newsletter and perhaps some events (Gilbert, 2006). Although these changes allowed some cost savings (e.g., reduced printing costs), they still did no more than replicate existing communication practices.

The Social Networking Choice Challenge

However, the massive influx of social networking technologies and their widespread adoption by the general population has created the perfect storm for healthcare organizations willing to invest resources in these technologies to regularly connect with constituents (Farmer, et al., 2009). No longer does an organization need to wait for a quarterly newsletter or enough information for an e-mail missive. Instead, the organization can post short bursts of information about potential opportunities, future and recent events, healthcare education, etc. to current healthcare consumers, providers, or the community at large who subscribe to one of the organization's social networking accounts, or visit one of its sites. These targeted information snippets keep the organization at the forefront of people's minds on a recurring basis with little to no active effort on the recipient's part.

Why then, have studies shown that social networks are still a mixed bag when it comes to effectively using them to support an organization's mission and goals (Cravens, 2010; Kaplan and Haenlein, 2009)? Cravens notes that particularly in non-profits the lack of in-house expertise and budget restrictions are the two primary reasons why organizations do not use social networking sites (19). The point is underscored with successful organizations committing staff and training to utilize the social networking resources without, at times, a "demonstrable return on the investment along with measurable contribution to their mission" (11) yet in place. In other words, there is a large front-end investment without a measurable ROI since these social networks are not only new endeavors but also defy accepted measurements of success (NTEN, Common Knowledge, & ThePort Network, 2010). It is easy to imagine that these conditions exist in healthcare organizations as well given budget and staff constraints.

It seems to us then that although we can encourage healthcare organizations to devote staff time and acquire training in the use of social networking technologies, as researchers we are not able to provide these items within the context of our study. Instead, we can help by examining the decision processes, rationales, and social networking implementations of organizations that are currently using these technologies. From these findings we can then develop a heuristic that will enable organizations to make social networking decisions that have a better chance to succeed within their particular organizational culture and available resources.

Paper Organization and Purpose

This paper is part of a larger research project that looks at developing an expert recommendation mechanism for technology adoption. In this particular paper, we look at how management can best choose the social networking technologies that it needs to meet an organization's mission and goals. This is an ongoing research project and we welcome input as we revise and hone approaches to this ongoing challenge.

In this paper we will first define social networks in order to create a set of categories through which we can present the various features, options, and potential use of social networks to organizations implementing specific technologies to meet their needs. We will then present our Social Network Adoption Matrix (SAM) used to determine what social technologies best meet the needs of an organization. From there, we will provide an example SAM to illustrate how evaluations and rankings can be used to present the best ranked choice to meet an organization's social networking endeavors. Next, we will move into a discussion that implements the SAM into our Social Network Adoption Matrix Expert System (SAMES) prototype. We end with future research directions.

DEFINITION OF SOCIAL NETWORKS

For our study we do adhere to one of the more common definitions of a social network as "patterns or regularities in relationships among interacting units" (Wasserman & Faust, 1994). However, we must also consider the technology mediation among these relationships as opposed to more traditional geographically bound social networks. Wellman notes this shift from the definition of community from "densely-knit, bounded neighborhood groups" to a set of computer-mediated relationships that provide "sociability, support, information, and a sense of belonging" (p. 2031).

In other words, although social networks could provide connections for those who live in the same street, town, or region, they now also extend beyond geographical boundaries and provide less of a strong group bond and more of a loose association. This can be a challenge for many organizations wishing to create a close knit group of constituents, but can be a boon for educating people about a particular cause or providing information on support options. Moreover, even without strong group bonds, targeted information can be sent that applies to healthcare consumers, providers, and the community at large.

CATEGORIES OF SOCIAL NETWORKS

In order to limit the scope of this initial study, we have pre-selected the following social networks. They were chosen because they best represent current social network technologies. However, we envision that this list will need to be adjusted as the study moves forward because of the user input we receive compounded by ever-changing social network offerings.

- **Large Social Networks:** Facebook and MySpace are two of the main offerings in this category. High user densities with various embedded tools to facilitate interaction have made these social networks desirable destinations for organizations. We do see additional market penetration from Google+, but this does not yet have the widespread adoption among communities beyond early tech adopters to be significant yet in this study.
- **Professional Social Networks:** LinkedIn and Plaxo help organizations manage contacts and, in the case of LinkedIn, provide areas for focused group discussions. Both offer paid options that provide more support and management tools and are quickly increasing user numbers. In particular, LinkedIn now boasts over 115 million users with 83% growth of user accounts since 2010 (Taylor, 2011).
- **Custom Social Networks:** Ning and Wall.fm enable an organization to create a customized Web area with collaboration and discussion tools. Both offerings enable an organization to create a tailored social networking presence versus other offerings that only provide a single theme for all users. For example, most Facebook pages look very similar, but every Ning space reflects the organization's theme, with various layouts, components, and tools to choose from. Ning and Wall.fm have free and paid levels of service and support.
- **Blogs:** Blogs provide a public platform for sharing ideas, news, and other organizational events with interested users. Blogs are one of the first Web 2.0 technologies to be adopted in a widespread manner. Effective blogs require regular updates to content, but are easy to maintain. Sites such as Blogger, Xanga, and Wordpress offer various levels of support and services depending on the subscription model.
- **Micro-Blogs:** New to the social networking sphere, micro-blogs provide organizations with a delivery mechanism for short information messages or calls to action. Twitter has the largest user base and can provide an organization with a powerful communication medium. For longer messages, Google Buzz and Tumblr are a better choice. All have easy to use interfaces and support integration into other social networking tools.
- **Social Ranking Aggregators:** Although not platforms for creating new media for distribution, these social networking tools can be used to provide recommendations of not only organizational postings and newsletters but also related topical areas that can create interest in organizational missions and goals. By posting Web and article recommendations to Digg, StumbledUpon, and Reddit an organization can create a greater awareness of its causes. In addition, an organization can embed integration buttons back to the aggregator sites from its social media offerings, thereby encouraging site visitors to provide recommendations.

- **Social Network Q&As:** Although a staple in the technical community for many years via UseNet, BBSes, and discussion lists, community-driven question and answer sites have become a viable social networking area for discussing various topics of interest well beyond technology. These easy to use social networking sites allow an organization to educate users on relevant organizational topics such as recycling. Currently, StackExchange (2011) and Quora lead in this area.
- **Social Network Images:** Although not normally considered social networking platforms, image-sharing sites allow an organization to post and promote events and causes. Many sites, such as Flickr and Photobucket, allow for comments and user rankings as well as integration with other social networking sites via integration buttons.
- **Social Network Donation Portals:** Social networking sites that promote involvement within a larger community have seen an increase in membership and participation. Some, such as Kiva, have a specific focus for donations. How it differs, though, is that users take part in working with others to make loans towards a specific cause. Other sites, such as Give2Gether (2011), allow an organization to create a campaign that leverages social networking tools. Healthcare organizations can use these sites for specific donations to causes or charity events.

SOCIAL NETWORK ADOPTION MATRIX (SAM)

In order to determine what categories of social networks to recommend as a result of the survey, we have developed a preliminary matrix that embodies the major rationales for choosing a particular social network option as well as the challenges (i.e., staffing and training) that most organizations note precludes them from adopting social network technologies. Previous studies (Burns and Wholey, 1993; Rice, et al., 1990) on matrix adoption in healthcare and technology were used as starting point for our Social Network Adoption Matrix (SAM). SAM measures six criteria ranked on a scale from 1-5 (low to high requirements):

Network Density

Network density is measured in the number of social network participants. For example Facebook with over 500 million members has a high network density (2011) whereas a tailored social network centered on a specific topical area, such as Freecycle (2011) with a little over eight million members would have a lower network density. However, caution should be exercised if an organization's focus is recycling a social network like Freecycle already consists of those interested in the specific cause and may be appropriate to the targeted mission and goals.

Interactivity

Interactivity is measured by the number of posts and interactions among the social network members. Twitter has a high interactivity level whereas LinkedIn in general has a much lower level. However, once again, the organization needs to be aware that targeted groups in LinkedIn can have a higher quality level in terms of the posts than those in Twitter.

Visibility

Visibility is measured by how often the social network technology appears in search engines and is linked by other networks. The ability to easily link from an organization's web site to Facebook, Twitter, Google Buzz, and MySpace via integration button links is paramount to increasing the visibility ranking. The linkage of Web 2.0 content and news aggregator sites, such as Digg, StumbledUpon, and various others are also a measure of increased visibility for the social network (van Zyl, 2009).

Ease of Use

Ease of use equates with a set of parameters ranging from how easy it is for organizational staff to create accounts on the social network, how quickly posts can be made, and how easy it is to customize and maintain the social network area. This includes membership management, tailored information, and a myriad of other items. Of all the matrix items this can be the most subjective of the measurements, but can play directly into how well an organization can keep interactions among users at the forefront of its strategy (Simon, 2010).

Support Options

Support options fall into three categories: 1) what support is available on the social networking site itself in the form of FAQs, a Knowledge Base, and user support boards 2) what support available external to the site in terms of organizations (e.g., TechSoup) or support sites (e.g., WordPress user groups) and 3) the lack of support needed to run the site. For example, Twitter requires very little training to begin to use it.

Social Network Adoption Matrix (SAM)						
	Network Density	Interactivity	Visibility	Ease of Use	Support Options	Total
Large Social Networks						
Facebook	5	4	5	4	1	19
MySpace	4	4	3	4	1	16
Professional Social Networks						
LinkedIn	4	5	5	4	2	20
Plaxo	3	4	4	5	1	17
Custom Social Networks						
Ning	4	5	4	4	3	20
Wall.fm	2	5	4	4	2	17
Blogs						
Blogger	4	3	3	4	2	16
WordPress	5	5	5	4	5	24
Xanga	4	4	4	3	2	17
Micro-Blogs						
Google Buzz	5	3	4	4	1	17
Tumblr	4	4	4	5	2	19
Twitter	5	5	5	5	1	21
Social Ranking Aggregators						
Digg	5	5	5	4	2	21
Reddit	5	5	4	4	2	20
StumbledUpon	3	4	4	3	2	16
Social Network Q&As						
StackExchange	5	5	4	5	1	20
Quora	4	3	4	4	3	18
Social Network Images						
Flickr	5	5	4	4	2	20
PhotoBucket	5	3	4	4	1	17
Social Network Donation Portals						
Give2Gether	3	4	4	4	5	20
Kiva	4	3	4	4	2	17

Table 1: Social Networking Adoption Matrix

SAMPLE MATRIX RANKING OF SOCIAL NETWORKING TOOLS

In order to create our first prototype, we used our preliminary social networking tools list. The rankings in place are based on our evaluation of the preliminary matrix rankings gleaned via discussions, user experiences, and overall industry reports (Gartner, 2011). We expect these rankings to fluctuate given the volatile nature of many social networking options, as well as the influx of new offerings (e.g., Google+) that occur in a relatively short period of time within the social networking technology sphere. However, we wanted to create a baseline from which to start the research and have factored in for industry changes, as well as SAM and SAMES revisions as more survey results come in and are analyzed. However, these rankings were used in our preliminary prototype of the Social Network Adoption Matrix Expert System (SAMES) for testing purposes.

RESEARCH INSTRUMENT

With our Social Network Adoption Matrix (SAM) in mind, we developed a research instrument designed to examine what makes for the successful--or perhaps unsuccessful--use of social networking technologies in the healthcare sector. To guide our survey formation, we framed our research around the following questions:

- What are the major constraints in social networks as they affect decision-making?
- What type of information can an organization distribute via social networks?
- What type of information can an organization gather from social networks?
- How does the organization's ideology affect the adoption and use of social networking technologies?

Instrument Questions

Using Davis's Technology Acceptance Model (Davis, 1989), we created a set of questions organized in categories that would help us understand how an organization views social networks either in use or ones that they might intend to use.

Questions are posed within a seven-point Likert scale as well as within a qualitative context of open-ended questions followed up with interviews where appropriate.

Intention of use

- What does your organization attend to achieve through the use of social networks?

Satisfaction

- How would you rate your overall satisfaction with the use of social networks for your organization's overall purpose?
- How likely are you to recommend the use of social networks to other organizations?

Trustworthiness

- How would you rate your overall trust/confidence in the use of social networks to accomplish your organization's purpose?
- How would you rate social networks as a reputable means of accomplishing your organization's purpose?

Perceived Usefulness

- How would you rate the quality of social networks in achieving your organization's purpose?
- How would you rate the functionality/benefit/utility provided to your organization's stakeholders through the social networks that you use?

- How would you rate the sufficiency of the social networks used in communicating your desired message?
- How would you rate the improvement achieved from the use of social networks in your organization?
- Using social networks such as Facebook, Twitter, etc. would enable your organization to accomplish its purpose more quickly?
- Using social networks to communicate to stakeholders would increase the organization's performance?
- Using social networks would enhance your organization's effectiveness of its communication to internal and external stakeholders?
- Using social networks would make it easy to communicate to internal and external stakeholders?

Perceived Ease of Use

- How would you rate the overall ease of using social networks for communicating your organization's purpose?
- Would you find it easy to get social networks to accomplish what you want them to?
- Do you feel the interaction with social networks used in your organization is clear and understandable?
- How would you rate the flexibility of the use of social networks in achieving your organization's purpose?
- How would you rate your organization's knowledgeability of the use of social networks?
- Would it be easy to become skillful at effectively using social networks for communicating your organization's purpose?

Influence

- Who influences your use of social networks? (e.g., managers, donors, etc.)

SOCIAL NETWORK ADOPTION MATRIX EXPERT SYSTEM (SAMES) PROTOTYPE

Although more adoption model testing for question refinement is necessary, our preliminary trial shows promise. We combined SAM with our acceptance model to create a prototype of our Social Network Adoption Matrix Expert System (SAMES). In this system we are able to ask an organization's management not only what their needs are in terms of communication, outreach, education, etc. but also balance these against their current resources and staffing that would be required to effectively implement and manage social networking technologies. The preliminary results indicate that this could prove quite effective in winnowing down social networking technology choices for those organizations that have specific mission goals.

SAMES Architecture

In developing the SAMES prototype, we needed to encapsulate each entity within its own object because the decision was made to create the prototype using object-oriented principles to ensure maximum portability and rapid application development (see Figure 1). We had made a preliminary decision to use Python (2011) in combination with Pyke (2011) to allow for server side control and processing with an expert system wrapper for increased logical flexibility. All data is stored in a PostgreSQL database (2011) with each object in an individual table. Ultimately, we wanted a fast system that required minimal processing on the user's computer. In the next prototype, we will web-enable the interface to allow maximum access and increased usability.

As a result of our object focus, we grouped the social media offering as a separate entity organized with SAM attributes. This will also permit us to incorporate new social technologies into SAMES as they become proven. It will also enable us to remove some of the very technologies we currently have in SAMES as necessary (e.g., MySpace).

In order to ensure flexibility as our prototype evolves through multiple revisions, we decided to store the decisions in a separate entity keyed to the specific questions. Using this structure illustrated in Figure 1, we were able to then make decisions based on the questions presented to the users.

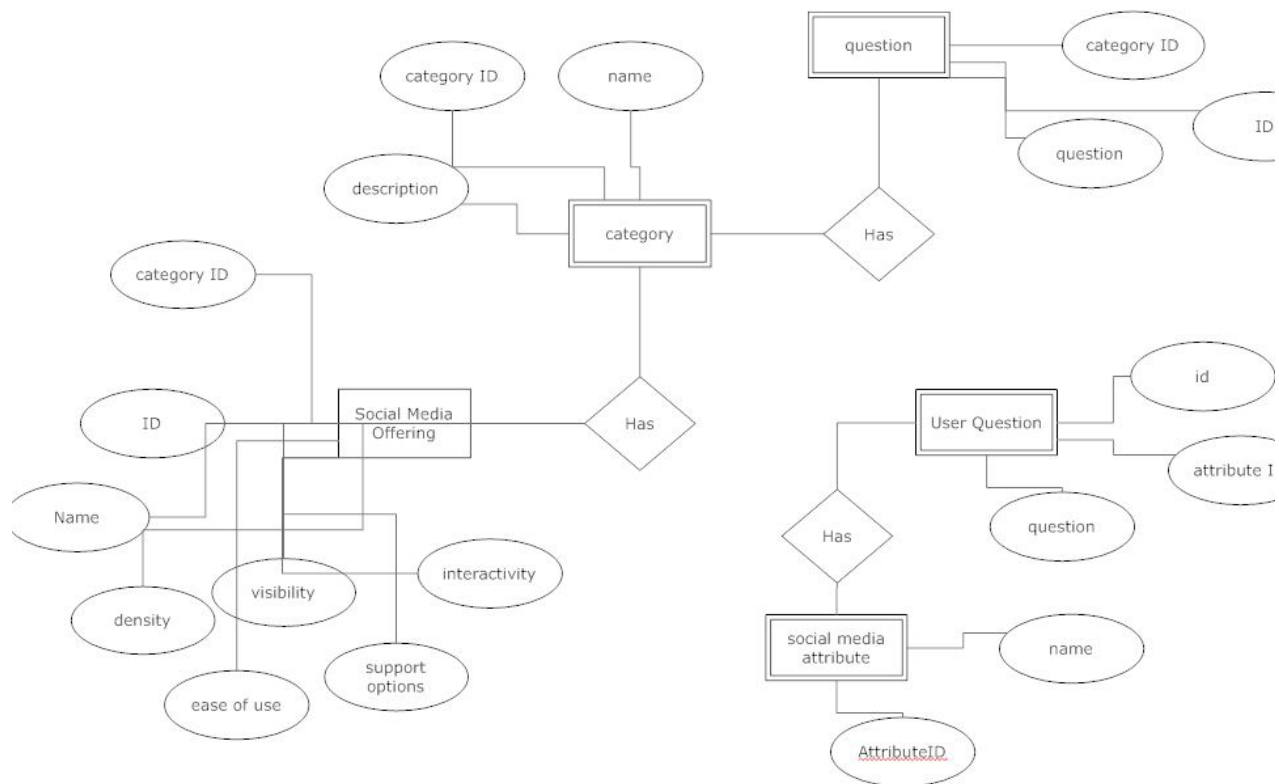


Figure 1: SAMES Architecture

SAMES Walkthrough

We enabled the user decisions using skip and branching logic to control the question flow according to the user's answers. A brief walkthrough (see Figure 2) illustrates the power of SAMES in assisting an organization to choose the most applicable social networking technology.

The organization is first presented with a list of nine questions to determine its overarching need. An organization can choose to repeat this process for different needs as well (e.g., communication versus recruitment), but in this example we will work through a single iteration of the SAMES decision process.

The preliminary questions in Figure 2 are the first step in helping SAMES meet an organization's needs. Each question helps SAMES focus the user in terms of intent rather than approaching the decision from a technology. This is important because technology changes and what might work for a specific purpose may no longer work within the span of a few months. For now, the user must only choose one of the nine questions, but plans are underway to allow for a combination of choices.

```

-----
Is a large concern of your organization raising funds for a charitable cause and/or are you interested in giving back to
in need?
Answer Number - 1
-----
Is your key purpose reaching a broad large audience regardless of who or where?
Answer Number - 2
-----
Are you trying to reach a specific demographic? That is are you concerned with creative control and the ability to tailo
ings to your specific needs and/or user groups.
Answer Number - 3
-----
Do you need to be heard often? Meaning is it important that you can quickly share and receive tidbits of information or
ce content with parties internal or external to your organization in real time?
Answer Number - 4
-----
Do you have a great deal of graphic content for people to see? That is do you wish to place and manage a significant amo
images online.
Answer Number - 5
-----
Are you interested in a platform to answer and/or ask questions? In other words, harnessing the power of collective info
to solve problems.
Answer Number - 6
-----
Are you concerned with staying up to date with respect to the web community? That is, focusing on what is popular online
spect to an online community or the interest said community has in your organization's presence in the community.
Answer Number - 7
-----
Are you primarily concerned with reaching out to other professionals, finding new employees, and/or developing new conta
h the business community?
Answer Number - 8
-----
Do you have a lot to say? That is, it is important for your organization to maintain and easily update a significant amo
content such as news, articles and/or advice.
Answer Number - 9
-----
Please enter the the number that corresponds to your answer: 9

-----
How important is the size of the online community you are trying to reach ?
Please enter a value 1 - 5
Your answer:

```

Figure 2: SAMES Opening Screen

Once a goal is selected, a particular question pool is queued. From this pool of questions, SAMES will select the first in a potential series depending on each user selection. In most cases, a set of five questions is standard. In Figure 3, we can see that these questions mirror our SAM. As the organization answers these questions on a likert scale of 1-5, with 1 as the lowest, SAMES can determine which current social networking technology the organization should consider. Although Figure 3 shows these questions in one screen, they are presented to the user one at a time and then displayed with the results.

In our example, then, the organization has decided that it needs "to maintain and easily update a significant amount of content" (Figure 2). Knowing that some social networking technologies are not designed to meet this need, such as Twitter, SAMES can eliminate certain potential solutions. From this response, the organization is asked to rate questions according to SAM needs such as audience size, features, visibility, ease of use, and training and support.

```

-----
How important is the size of the online community you are trying to reach ?
Please enter a value 1 - 5
Your answer: 4
-----
How important are advanced capabilities and features, such as user accounts, user customization and things of that nature?
Please enter a value 1 - 5
Your answer: 2
-----
How important is it that people see your organization online? Think if you will be directing traffic to the site from your business or if you are hoping to spread the word about your organization?
Please enter a value 1 - 5
Your answer: 5
-----
How easy to use would you like your social media offering to be? Think in terms of your skill level and your target users?
Please enter a value 1 - 5
Your answer: 3
-----
Please rate how important support options are? If you need help how much would you like to rely on a respective social media organization?
Please enter a value 1 - 5
Your answer: 4
-----
blogger
[2, 1, 2]
-----
wordpress
[1, 2, 1, 1]
-----
xanga
[1, 2, 2]
-----
SAMES recommends your organization adopt:  blogger
-----

```

Figure 3: SAMES Custom Recommendations

The results presented in Figure 3 show the organization the social networking technologies that are the top three choices with a suggestion--in this case, blogger--as to which one it might use. The numbers in parameters are for our research use as we track the arrays of data that SAMES choose in making this decision. In final versions, these numbers will not be present.

SAMES Shortcomings

Although the SAMES prototype enables an organization to quickly narrow its list of potential social networking technologies from an ever-growing Web 2.0 miasma, it does need improvement and refinement. In the next prototype revision we will present the SAMES interface via a Web browser. With the use of forms, graphics, and CSS, we can make for a more familiar and usable experience to our users. For example, instead of entering a "1" on the keyboard, a user will be able to select a radio button. With the addition of graphics we will also be able to offer screenshots of the various social networking technologies as well as provide links to them and potential support sites.

In addition to ease of use considerations addressed with a Web interface, increased selection of social networking technologies will be an ongoing endeavor. Moreover, permitting users to select more than one goal and answer criteria along the way that may result in a complete package of social networking technologies is being pursued. This will take more work in terms of the logic used to make selections, but will be more welcome than requiring the organization to run through multiple iterations of SAMES selection to fulfill all of its needs.

FUTURE RESEARCH DIRECTIONS

As noted in the SAMES shortcomings, our research into the most effective paths for social network adoption for healthcare organizations needs to evolve and expand to not only include more social networking technologies but also other types of organizations.

We also need to return to our technology adoption model to ensure that we are addressing all needs. Although we do not foresee this resulting in the removal of any SAM areas, it is likely that current areas will need refinement and possible that additional constructs might need to be measured. We welcome input to these ends.

Our preliminary prototype of the Social Network Adoption Matrix Expert System (SAMES) is definitely in the beginning stages and needs to be refined in the ways noted above. We hope to produce a refined prototype in the coming year and deploy it to a larger set of organizations from which we can survey and refine the SAMES based of their interaction and recommendations.

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Curriculum Development on Healthcare Information Systems, Healthcare Supply Chain Management and Healthcare Operations Management

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ABSTRACT: This paper presents the foundation for curriculum amendment in the College of Business at Eastern Michigan University to prepare our students for the tremendous job opportunities that are presently available in the healthcare arena. Specifically, this curriculum change incorporates three major areas in healthcare management: Healthcare Information Systems, Healthcare Supply Chain and Healthcare Operations Management. In order to properly chart the changes in the curriculum, research is presented that defines and discusses these components for suitable curriculum building that will enable graduates to effectively perform in the healthcare industry. Additionally, presented in this paper are the detailed objectives and teaching pedagogy of a special topics graduate course in Healthcare Operations Management that recently has been developed at Eastern Michigan University.

INTRODUCTION

In healthcare, a system known as “pay-for-performance” or “P4P” is critical to improve the quality of patient care. This P4P (the “ACT”) program is an outgrowth of the Deficit Reduction Act of 2005 and was passed by the U.S. Congress. It represents attempts by the U.S. government and private enterprise, such as insurance companies and healthcare purchasing consortiums, to require healthcare institutions to meet certain objective criteria that will increase the quality of care, while at the same time reducing healthcare cost. Under this Act hospitals and healthcare systems are eligible to receive higher Medicare and Medical reimbursements if they can demonstrate certain types of operational efficiencies and productivity improvements¹. Increased operational efficiency and healthcare productivity gains can be achieved through healthcare informatics; integrated healthcare delivery supply chain systems; and adapting operations management techniques to the healthcare industry.

Because there is indeed a huge demand for people who excel in these areas of the healthcare field, schools are rethinking on how to teach and apply informatics, supply chain management and operations management techniques (so effectively used in various non-health related industries) for use in the healthcare sector. In consistent fashion, the U.S. Department of Health and Human Services (HITECH) Grant program, issued in 2010, that provides Universities and Community Colleges with funds to develop programs in healthcare information

¹ Based on “Enterprise Integration: Defining the Landscape” (a work product of the HIMSS Enterprise Information Systems Steering Committee and the HIMSS Enterprise Integration Task Force)

technology (HIT) and healthcare operations management is a clear indication for the timely development of such new curriculum.

CHARTING A CURRICULUM FOR HEALTHCARE INFORMATICS

Charting the curriculum for healthcare informatics must be guided by the future need for health information technology (HIT), such as healthcare enterprise integration (the ability to access data across multiple systems using healthcare information technology); the development of semantic web-based systems that make it easier to share and reuse information by people and applications; the explosion of the new imaging and innovative technologies such as RFIDs and mobile computing; privacy and security issues; e-health for convenient medical information exchange; artificial intelligence; and others (Rastogi et al., 2008).

Our initial attempt to develop a sound curriculum was the introduction of a Graduate Certificate in Healthcare Informatics, sponsored by the College of Business Computer Information Systems department and the College of Health and Human Services School of Health Sciences. This program covers the fundamentals of IS/IT applications and introduces the students to IS terminology, structures, applications, and their relationship to managerial functions in healthcare organizations. The graduate certificate brochure states that “ultimately, the program seeks to provide students with an understanding of the basic structures of information systems in health administration; the relationship of these systems to managerial functions, such as communications, coordination, control, strategic and process planning and decision making; and the important policy and ethical issues associated with privacy, confidentiality, and security in information systems.”

Students participate in coursework in Medical Care Organization, Informatics in Healthcare Management, and Web Application Development. They have the choice to take either Health Law or Healthcare Finance and must select two amongst the following four courses: Systems Analysis and Design, Database Management Systems, Enterprise Resource Planning or Systems Intelligence. A total of 18 credit hours is required for this certificate.

CHARTING A CURRICULUM FOR HEALTHCARE SUPPLY CHAIN AND OPERATIONS MANAGEMENT

Background and Components of Healthcare Supply Chain Management

The growth of HIT is fueled by the desire to achieve better integration in the healthcare delivery supply chain. The healthcare supply chain is complex and can broadly be conceptualized to span upstream from the development of care (e.g., equipment and device manufacturers, bio-tech firms, etc.) to the midstream financing of care (e.g., CMS, insurance companies, and other payors), to the downstream delivery of care (e.g., hospitals, physician providers, etc.) (Sinha and Kohnke, 2009). Unpacking and exploring the complexity of the healthcare delivery supply chain is an important aim for future healthcare operations and HIT professionals. Therefore, coursework that prepares these health professionals to better integrate healthcare delivery is well served to address the following unique dimensions of the supply chain.

- *The co-production phenomenon* (Chase and Tansik, 1983; Schmenner, 1986; 2004; Smeltzer and Ramanatha, 2002). In other words, customers participate in the value creation process and have contact with providers in service provision.
- *Actor role ambiguity* (Schneller and Smeltzer, 2006). Suppliers, the focal firm, and customers maintain well defined roles during their interactions aimed at value creation in manufacturing. This is not the case in healthcare, as a physician may serve as a supplier of patients to the hospital (focal firm) when referring patients for admission, but also acts as a customer of the hospital in ordering tests. Likewise, the patient is a customer to the hospital and physician, but is also the material input (with inherent variability) in the input-output transformation process. This calls for curriculum content which emphasizes relational coordination mechanisms in the healthcare delivery supply chain (Shah et al., 2008).

- *Variable demand* (Schneller and Smeltzer, 2006; Shah et al., 2008). The co-production phenomenon and actor role ambiguity mention previously drive variation in demand volume and variety that does not often exist in manufacturing. This is exacerbated by the growing size of the customer base in healthcare described in the ‘background section’ previously.
- *Centrality of the physician* (Smeltzer and Ramanatha, 2002; Schneller and Smeltzer, 2006; Ford and Scanlon, 2007; Shah et al., 2008). In manufacturing, the exchanges which occur during value creation are largely directed by the focal firm using contracts and financial arrangements which articulate quality, cost, and delivery specifications. This is not the case in healthcare delivery as physicians, who are commonly employees of the hospital, make many decisions which influence the operational performance of the hospital along the same operational measures of quality, cost, and delivery (Smeltzer and Ramanathan, 2002).
- *Information asymmetries* (Ford and Scanlon 2007). Hospitals have been slow to adopt HIT. While the American Recovery and Reinvestment Act passed under the Obama administration is expected to accelerate HIT adoption, at present asymmetrical information/knowledge stocks exist among providers, negatively impacting operational performance. As these asymmetries quickly diminish, healthcare operations and HIT professionals should be versed in RFID which can be used to track physical assets (materials) (Amini et al., 2007) as well as technologies such as electronic health records are used to manage information (Jha et al., 2009).

These (and other) characteristics make healthcare delivery unique from manufacturing, and lie at the heart of why specialized academic programing is needed. It is not sufficient to simply apply OM and SCM concepts in healthcare (Smeltzer and Ramanathan, 2002). Rather, training programs that are developed with an understanding of the unique context of healthcare delivery will likely yield more effective results. It is with this understanding that the above key course topics have been identified.

Background and Components of Healthcare Operations Management

Heineke’s (1995) research suggests that there is an important link between sound healthcare operations management decisions and technical performance in healthcare maintenance organizations. She suggests that technical performance in healthcare will be enhanced when professional work is appropriately managed using Operations Management and Lean principles leading towards sound decisions about organization, strategies, workforce management, inventory management, planning and control. Indeed Healthcare Operations Management uses and adapts traditional Operations Management principles and techniques to reduce cost, improve quality, allow for flexibility, and effectively increase responsiveness to patient care. Research shows that some hospitals and healthcare centers are successfully using Operations Management strategies, techniques and principles such as: lean process and workplace re-engineering (via value stream mapping, kaizen, A3, 5 Whys, 5Ss); quality management to improve patient care and patient safety; inventory management strategies and systems that address variable demand; scheduling techniques for both planned and unplanned admissions and for emergency centers; capacity management of the labor force and capital equipment; facilities planning in terms of location analysis and healthcare facilities layout; and many more. These must be the focal point in developing the Operations Management curriculum for Healthcare professionals.

A Sample Special Topics Graduate Course in Healthcare Operations Management

The initial special topics graduate course in Healthcare Operations and Supply Chain Management, developed at Eastern Michigan University, was designed to provide students with Healthcare Operations Management tools to improve performance in healthcare management; to improve healthcare processes and procedures; to better manage inventories; to improve the quality of healthcare delivery; to more accurately schedule patients and capacities in a dynamic demand environment. Additionally this course covers customer relationship management and health information technology.

Students successfully completing this course should be able to:

- 1. Understand the role of OM in the healthcare delivery system.
- 2. Discuss and interpret the six health care operational effectiveness criteria (lowering health care costs; increasing health care productivity; continuous health care process improvement; reduction in health care variability; improving logistics flow; and improving quality of patient services).
- 3. Master and implement the tools and techniques for re-engineering health care processes (Process Maps; 5Whys; Value Stream Mapping; Go See; A3; Mistake proofing; etc.).
- 4. Forecast capacity need and patient flow for better scheduling.
- 5. Create appropriate schedules for patients and hospital personnel requirements.
- 6. Track systems to improve patient and materials flows.
- 7. Implement Quality Management
- 8. Formulate labor and capital productivity improvements through optimal staffing and scheduling models.
- 9. Illustrate document reduction using the 5S principles of Lean Operations Management.
- 10. Use project management as a tool to affect change in Healthcare.
- 11. Debate and examine how change management effectively sustains changes made in health care procedures and processes.
- 12. Evaluate healthcare decisions, procedures and processes and use appropriate tools to improve systems.
- 13. Map and examine the supply chain in the healthcare industry.
- 14. Design and manage inventory and supply systems.
- 15. Formulate models that are specific to health care location analysis.
- 15. Design layouts of hospitals and clinics for improving service and patient flows.
- 16. Assess a hospital's use of technology (e.g., Internet, Personal Health Records, etc.) for patient engagement and select from various alternative technologies used in CRM.
- 17. Integrate various technologies into hospital operations to better manage cost and quality (e.g., RFID).
- 18. Develop a technology plan for a hospital and choose among various technologies appropriate for the hospital's specific application.

Eastern Michigan University is not affiliated with a Hospital or Health System. However, its faculty in Computer Information Systems and Operations and Supply Chain Management have existing research relationships with major Hospitals and Health Systems. It is the amalgamation of this research and the course material that will enable students to gain practical knowledge about the implementation of various principles and techniques taught in this healthcare curriculum. In addition, the practical study and analysis of various case studies will aid in placing the theory in unique context of the healthcare delivery system and thus yield practical and effective results. (see figure 1: Summary of an implementation case at the U of M).

Additionally for each major topic discussed in this course, reading(s) specific to healthcare management will be selected from various journals, such as: Production and Inventory Management, Decision Sciences, International Journal of Production Economics, Journal of Operations Management, Production and Operations Management, International Journal of Operations and Production Management, International Journal of Production Research, Management Sciences, Operations Research, and Manufacturing and Service Operations Management. A Readings list for each covered sections is given to the students during the first class meeting. Each student in the class is required to lead the discussion of at least one of the reading assignments. So that all students are participating in the discussion of all reading assignments they must submit a summary of each reading assignment before class discussion takes place. Participation in these discussions is essential to learning, so students are expected to come to class, be prepared, and actively participate.

The U of M Hospital: Re-engineering an Admissions' Process using VSM.

Around 2005 University of Michigan Hospitals began an initiative to bring Lean problem solving methods and culture to the Health System. As part of that initiative grants and Lean coaching support was made available to a number of projects in both the inpatient and outpatient settings. The Department of Physical Medicine and Rehabilitation received such a grant in 2007 to address the issue of timeliness of patient transfer to the rehabilitation floor. The transfer of a patient from an acute medical service to the rehabilitation service requires coordination between both physicians and nurses on the sending and receiving services, housekeeping to prepare the beds, transport, and multiple steps required to obtain insurance approval for the transfer. Delays in transfer resulted in lack of therapies the first day of transfer and both patient and staff dissatisfaction. Additionally, with the rise in acute medical census any delay in discharge of patients to the rehabilitation unit potentially could cause delays in admissions of patients from the emergency department or postoperative holding. The issue of delayed admissions had been a long standing problem, and previous attempts to improve the process were ineffective.

Through the UMHS grant, the Department of PMR received a Lean coach to assist with the process and educate all participants in Lean principles. After an initial scoping phase, a two day workshop was convened to analyze the current process through value stream mapping and to formulate a future state map and develop an implementation plan. The group assembled included representatives from all steps in the transfer process, including physicians, nurses from both the rehabilitation floor and from acute medical floors, therapists, discharge coordinators, and the rehabilitation floor admission coordinator. Key deliverables and metrics were identified to bring the desired process change and specific individuals or groups were tasked with implementation of those changes, with specific time frames and regular progress meetings. At the end of the workshop the findings and implementation plan was presented to hospital administration to get leadership buy-in to the project. Another key strategy for process change was close monitoring of key time goals for every admission with analysis of events that fell outside of goal time lines. This allowed daily feedback and early identification of areas for improvement.

Results from the project have been quite dramatic. Prior to initiation of the project in early 2008 only 18% of patients arrived to the floor by 1 pm (average admission time 4:30) and no patients received therapies on the day of admission. By early 2010 65% of patients were physically on the rehabilitation unit by 1 pm and 92% of patients did receive therapies on that day of admission. In addition to achieving the goals set out by this project, it served as an example of the power of Lean process re-engineering to bring meaningful change and became a springboard for other projects in the Department of PMR.

**Figure 1: Summary of an Operations Management Healthcare Implementation Case
(Wu, Parfenyuk, Craig, Craig, 2011)**

CONCLUSIONS AND FUTURE RESEARCH

A need exists for university programming in the area of healthcare informatics, healthcare delivery supply chain, and healthcare operations management. Such programming is necessary in order to prepare healthcare managers to develop and manage organizations which are successful in delivering both high quality as well as cost effective care. This paper has illustrated the initial efforts undertaken by Eastern Michigan University to establish such programming. While this paper has made a contribution to the literature by establishing the need for healthcare programming and describing the key elements thereof, future research should provide additional detail regarding curricular advancements in this area of study. Additionally, studies which address the measurement of learning outcomes in this context would be useful, as Colleges of Business work in a new interdisciplinary fashion with other Colleges such as Health and Human Services.

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Say Good-Bye to the Silos and Hello to Collaboration: A New Curriculum Approach

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Abstract: In sharp contrast with the customary traditions of educational silos in the delivery of knowledge and understanding, this paper presents a true interdisciplinary curriculum that is designed to supply the community with graduates who are prepared to take on diverse roles in health care and information management. The complexity of our modern communities and their anticipated futuristic needs suggest that graduates in health care must be able to apply more than a traditional singular knowledge domain to articulate problems and provide solutions to those problems in meaningful ways. The curriculum approach presented will facilitate interdisciplinary knowledge learning from existing classes, foster faculty collaboration, and enhance the resource sharing and integration. In essence, this new curriculum collapses the boundaries of education silos.

INTRODUCTION

Health care is one of the top social and economic problems facing Americans today. The rising cost of medical care and health insurance affects the livelihood of nearly every American in one way or another (Ginsburg, 2008). Recent studies indicate that one of the key reasons that cause the skyrocketing increase in U.S. national health care spending is lack of information sharing, which subsequently results in medical errors and waste, along with the increasing concerns on health care service quality, safety, and accessibility. While the health care problem is not easy to solve, timely actions must be taken to prevent its further worsening or, more positively, to eliminate its root cause of errors and waste. As recognized by the health care professionals, one possible and effective solution to the health care problem is to apply health information technologies (HIT) to enable the digitization and sharing of health information that will not only avoid the duplications, errors, and waste but to enhance the efficiency of health care service without compromising its quality (Falan et al. in-press).

Over the years, advances in information technology and changes in healthcare delivery have expanded the demand for healthcare information within and beyond institutional boundaries. The environmental trends that have contributed to this expansion include the push for patient safety using evidence-based practice initiatives and decision support, health care consumer involvement in decision-making, and the electronic health record. Based on a recent labor market report, published by the U.S. Bureau of Labor Statistics (2011a), health care is one of the largest industries and it provided 14.3 million jobs for wage and salary workers. More strikingly, ten of the top 20 fastest growing occupations are health care related. Specifically, the healthcare industry will generate four million new wage and salary jobs between 2008 and 2018, and during the period, business and professional services will generate 2.6 new jobs (U.S. Bureau of Labor statistics (2011b). This unmet job demand is primarily in response to the rapid growth in the elderly population. In the report, it is also pointed out that a good percentage of these jobs will require four years of college education (U.S. Bureau of Labor Statistics, 2011b).

In response to the emerging needs of health care that more health care professionals must be well versed in the knowledge and management of information technologies and as well as to echo the Academic Strategic Plan 2010 of the university (Western Michigan University, 2010), the faculty developed and have proposed a university-wide interdisciplinary undergraduate curriculum, entitled *Health Informatics and Information Management (HiIM)*. By nature, HiIM curriculum is interdisciplinary. The premise of HiIM curriculum is to leverage the talents of WMU faculty for program delivery while enhancing investment in faculty and staff development. Therefore, implementing this curriculum will involve minimal administration overhead and little resource duplication at each college. This paper discusses the health information technologies, the market demands of professionals who work in health care and the interdisciplinary curriculum that has been designed to build needed skills in our community.

Information and Communication Technologies (ICTs)

Great efforts have been made to infuse technology into health care to improve productivity, decrease error, and produce better outcomes (DesRoches & Jha, 2009; Gagnon et al., 2009). Health technologies have been designed to provide an array of functions from automating inventory and restocking of drugs on medication carts to the use of robotics to deliver health care to those that are geographically separated from providers. Health care technologies affect not only health care practitioners that deliver health care but also the recipients of that care. One classification of health care technologies, the information and communication technologies (ICTs), is used to capture processes, store, retrieve, and share clinical information. ICTs are designed to interface with multiple systems and programs to allow for input and computation so that decision support can be utilized to improve care. While many health care technologies are ubiquitous, electronic health records on an interoperable ICT have been slow to emerge.

Electronic Health Record (EHR)

The EHR system is designed to manage, store, share, retrieve, and communicate information about the health status of individuals. It is a record of the patient's health care experience that includes the medical problems, treatments, referrals, and outcomes. The EHR also serves as a way to determine quality and promote process improvement (DesRoches & Jha, 2009; Carter, 2008). Health care organizations have been slow to embrace EHRs until the past few years when the government initiated and influenced the adoption rate of electronic health records for managing information (The United States 111th Congress., 2009; Congressional Budget Office, 2008). Although the Institute of Medicine defined critical functionality in 2003 (Committee on Data Standards for Patient Safety, 2003) and the criteria was further expanded and clarified in 2009 (Jha et al., 2009) wide spread adoption of the EHR is limited due to lack of consensus on key functionality. Jha et al. cited that barriers to EHR adoption also include financial constraints, maintenance costs, employee resistance and lack of adequate information technology expertise (2009).

Recently, in response to the financial concerns and to ensure that the EHR would be used in beneficial ways, meaningful use criteria emerged that offer incentives (thousands of dollars) to organizations and providers who implement systems and demonstrate that they use the systems meaningfully. If practitioners purchase systems that use incentives, but do not show "meaningful use" then the incentives are not awarded. Examples of meaningful use criteria for the first stage adoption for the 2011-2012 year include having a patient list, medication list, use of computerized order entry, patient electronic access, clinical summary and so forth (Centers for Medicare and Medicaid Services, 2011). In order to take advantage of the meaningful use incentives, systems and policies must be designed that align with meaningful use criteria and people must have the information management and systems skills to accomplish those goals.

Many health care and information technology analysts believe that health information technology (HIT) will have positive impacts once implemented, however the benefit is often more speculative than fact or biased due to research methodology (Congressional Budget Office, 2008). The perception remains consistent that the EHR provides benefits such as improved data accessibility, improved reporting, quality and safety measurement, improved outcomes and patient safety (Yoon-Flannery et al., 2008; Carter, 2008).

To date, the transition from paper-based records to electronic health records has created a job demand for health care professionals to concentrate on the domain knowledge that encompasses health care and information technology and their associated management. The historic move from paper to electronic health records and the most recently passed national health reform bill that mandates health information be exchangeable among organizations, service providers, patients, and other health care stakeholders (e.g., insurers, government agencies) changes the fundamental processes of health care delivery. These changes have created a great challenge to those working in education to prepare students for these roles. While many academic programs and departments (e.g., nursing, business, music therapy, occupational therapy, physician assistant, and computer sciences) have attempted to make students understand and deal with issues associated with information management, the emerging market demands more graduates with integrated education in both health care and information technology. Specifically, the new positions require a deeper knowledge of how health care delivery and operations could be enhanced, enabled, and streamlined by meaningful employment of health information technology.

MARKET DEMAND

A recent report released by HealthTechnica (2010) shows that the healthcare information technology market is estimated to be \$53.8 billion by 2014, growing at a compounded annual growth rate (CAGR) of 16.1% over the period between 2009 and 2014. The market is expected to grow because of the tremendous demand for general applications that include electronic medical records (EMRs), EHRs, computerized physician order entry system (CPOE) and non-clinical systems. It is expected that the market for general applications will grow at an overall CAGR of 13.0% over the same period.

There exists an unmet market demand for health informatics and health information technology professionals to cover workforce shortage for almost all the segments within the health care industry. The demand for health IT professionals was spurred by the 2009 federal American Reinvestment and Recovery Act (ARRA). The government legislation provides millions of dollars in increased Medicare and Medicaid reimbursements to hospitals that meaningfully implement an EHR system by a 2011 deadline (The United States 111th Congress, 2009). These incentives become penalties for hospitals that have not implemented an EHR by 2015. With a finite number of technology professionals in the healthcare industry, and only 1.5 percent of U.S. hospitals currently using comprehensive clinical information systems, a huge gap in the supply/demand exists (Falan and Han, 2011).

In addition, the labor market report published by the United States Bureau of Labor Statistics indicates that health care is one of the largest industries in 2008, and it provided 14.3 million jobs for wage and salary workers (2011b). More strikingly, ten of the top 20 fastest growing occupations are health care related. In specific, the healthcare industry will generate 3.2 million new wage and salary jobs between 2008 and 2018, which is more than any other industry. This report confirms that the market demand for a specialized advanced degree that integrates Health Informatics with Information Technology is growing and shall be met by the future graduates from American four-year colleges and universities (U.S. Bureau of Labor Statistics, 2011b).

As demonstrated, there is a strong push for health care providers to use electronic approaches to manage information to improve quality, reduce costs and conserve resources. At the same time, this creates an urgent need for health care workers, clinicians, information technology professionals, managers and administrators to have more knowledge and skills related to health information management and systems. Next, an academic response to the emerging demands for health care professionals to have health information technology knowledge and skills is presented.

CURRICULUM

Western Michigan University established the Center for Health Information Technology Advancement (WMU-CHITA) in 2010. The center, supported by the university, is administered through a joint effort of two faculty representing the Haworth College of Business and the College of Health and Human Services. The Center's mission is to build programs in research, education, and service that will help students gain new knowledge and skills in the area of health care and information technology. As part of the mission, the faculty of the Center determined that there was a need for a new major to help prepare students for future roles and the need for change began with a review of errors in health care (Falan, et al., in press).

Why is this Curriculum Important?

Health care is fraught with errors, redundancies and escalating costs (Falan et al., in-press, PricewaterhouseCoopers, 2009; PricewaterhouseCoopers 2008; Rand 2010; Institute of Medicine, 2000). These issues originate from several perspectives, but some are particularly important. First, many health information technologies actually introduce error into health care processes with adverse effects (Horsky, Ahang, & Patel, in press; Sarnikar & Murphy, 2009; Ash et al., 2007; Harrison et al., 2007; Heeks, 2006) and systems are missing requirements that result in interruptions in task performance, inadequate functionality, missing or inadequate feedback (Sarnikar and Murphy, 2009).

System design is not the only issue involved with the problems in health care delivery. Clinicians want to have adequate information to make day-to-day decisions, yet have little knowledge or experience how to derive more out of the systems they use or desire to build (Revere et al., 2007). The health care professions have distinct information requirements that make collecting the needed information challenging and suggest that a one-size-fits-

all approach will not meet the needs of health care professionals. The health care disciplines must be able to identify their unique information needs so that it is available in the systems themselves. These problems can be resolved. In order to influence health care errors, systems, and health information management problems, university graduates must be armed with the skills and tools to be effective in solving these problems.

Academics

Creating and using systems that benefit clinicians and patients begins in academics with the fundamental knowledge that students acquire related to health care and information management systems. Given that the demand is growing for health care professional skilled in health information management, we explored many different ways to bring the necessary knowledge to students and concluded that a new curriculum major was warranted. The pervasive downturn of the economy and financial constraints of the university along with the desire for an interdisciplinary curriculum led us to think about different ways of offering the major. Faculty's objectives for the proposed curriculum were to minimize the cost to the university, use existing resources and engage faculty. Faculty reviewed sample programs across the nation and the criteria for accredited programs in this knowledge domain. Based on the review, it was determined that many curriculums centered on information management but lacked essential health care domain knowledge. Additionally, the faculty wanted a curriculum that could be utilized as a double major for those engaged in clinical curriculums. Therefore, it was essential to review the requirements of other majors in terms of courses that will give students an advantage toward a double major.

As a result, faculty from different schools and colleges collaborated to establish a new curriculum major called Health Informatics and Information Management (HiiM). The HiiM major is interdisciplinary in its design to promote the collapse of academic silos and increase the sharing of teaching/knowledge/research resources across multiple colleges at Western Michigan University. This curriculum provides students with the latest developments in health care information management and systems. The undergraduate major interdisciplinary curriculum, HiiM, consists of seven pre-HiiM courses in the human sciences (including medical terminology, biology and statistics, anatomy and physiology), eight core required courses, and three specialty courses offered by hosting colleges at WMU. A few of the eight core courses include Informatics for health care professionals, Health Information Systems and Management, Systems Analysis and Design, Information Assurance and Compliance, Capstone project, Health Services Practice management. Each hosting college offers its own unique specialty courses like the following: Business Analytics, Data Mining, IT project, Health Systems and the Environment, and Independent Research.

The expected outcomes of the curriculum follow the Commission on Accreditation for Health Informatics and Information Management Education (CAHIIM) that include demonstration of competencies in:

- Health data management
- Information policy
- Information systems
- Administrative and clinical workflow

The major domains of the curriculum are designed to flow logically with the 2011 AHIMA Curriculum Competencies (AHIMA, 2011) which include:

- Health Data Management
- Health Statistics & Research Support
- Organization & Management
- Information Technology Systems
- Organization and Management

This major will produce graduates to meet the market demand for both balanced and specialized knowledge/skills in the combined domain of health informatics and information management. The interdisciplinary nature of this new major will provide a unique field of study that will better prepare students to acquire both health care domain knowledge and the education in information management before pursuing their future careers.

Whereas many curricula originate within a single college or department, this major is designed to be scalable in terms of participation from all colleges across the university and is categorized as a university level major. The courses for this curriculum were selected from courses offered throughout the university. All courses

within the university offerings were reviewed for applicability to the major proposed using a keyword search. The faculty found many courses to apply to the HiiM major from across the university. The courses selected for the curriculum were based on the criteria for accreditation for health information management programs by the American Health Information Management Association (AHIMA, 2011). Once applicable courses were identified, faculty were contacted to determine if they would be willing to closely align content of a course section offering to fulfill the criterion requirements from AHIMA. The majority of the required courses for the major are derived from the College of Health and Human Services, College of Arts and Sciences, and Haworth College of Business. The courses selected for this major provide graduates with a background in healthcare and business processes that are essential for success in their careers. The unique contribution of this major is its ability to generate specific skill sets across different knowledge domains. For example, students electing the HiiM major through the College of Health and Human Services will have the opportunity to choose specialty courses like health care literacy, health care administration and so forth. Those students who pursue the HiiM major through Haworth College of Business will have opportunities for in-depth study in data analytics, networking, project management, and security and more.

Benefits for Hosting College Graduates

Initially, two colleges will host the HiiM Major, the Haworth College of Business and College of Health and Human Services. As other colleges or departments join in the delivery of the HiiM curriculum major, the benefits will continue to grow across the university. Next, the benefits for the hosting college are described.

The College of Health and Human Services is designed to provide a collection of programs focused on improving the health and well-being of people and communities through skills, knowledge, and leadership. This proposed curriculum is designed to provide skills and knowledge in the capture, management, retrieval, and utilization of health care information that is essential for knowledge development and for promoting the health and well-being of people and communities. Additionally, graduates will gain a good understanding of workflow processes, system analysis and design, and information management that are derived from the courses in Haworth College of Business. This curriculum seeks to promote an interdisciplinary environment to build specific knowledge and skills that will be used by bedside clinicians, clinical managers, health information system designers, information technology managers, and administrators in the promotion of organization and/or entrepreneurial goals in health care. The most important benefit is that business students and health care students will develop interdisciplinary-domain knowledge instrumental for pushing health care forward in positive ways.

The Haworth College of Business (HCoB) focuses on business education with respect to multiple specialties. The HiiM Major will provide students admitted to HCoB the opportunity to combine their education in computer information systems and management with complimentary education from the College of Health and Human Services and the College of Arts and Sciences necessary to be professionals in health information technology and health care management. This new major offers business students with more blended training and education such that they can be employed by the unmet market demand in health care IT and management. The three specialty tracks offered by HCoB will provide business students with more options to pursue their career as specialists in data analysis, health care information networking, and health care management. In sum, the domain knowledge in business and computer information systems and their combination with the domain knowledge in health care will improve the placement of HCoB graduates.

DISCUSSION

The development of this major is intended to propel student learning in terms of health care and information management. While it is understood that many improvements can occur in health care, it will not happen without people and those people must have the necessary skills and knowledge in health, systems, and information management.

The creation of this HiiM curriculum was not a simple process. All faculty and departments impacted by this curriculum were consulted and provided the opportunity to contribute toward this endeavor. Several courses required content enhancement to conform to the criteria expected of AHIMA. To facilitate the correct content, we had more discussions with faculty. We found faculty that were interested in this curriculum and who were willing to implement changes to their courses to fit the

accreditation criteria. If faculty had not been willing to make changes to existing courses, it would have required the development of new courses. During this economic slowdown, it is unlikely that the university would support the development of a curriculum of new courses. Faculty buy-in is critical to the success of the curriculum development and approval.

It is interesting to note that many people in our university expressed excitement over the new curriculum and offered to us recommendations for this work. We listened carefully to those who gave us their ideas and recommendations for consideration. Due to the slow economic times, careful attention to costs and resources was essential. When we came to junctures where resources or capacity issues could be problematic, alternative solutions were created, which involve looking at essential content and determining how we could meet the requirements for accreditation differently.

CHALLENGES

As with any new curriculum development, there are challenges that will arise. In this case, due to the interdisciplinary nature of this curriculum, curricular management, capacity, and program management will be more complex than most traditional curriculum majors.

Curricular Modification

First, two hosting colleges will jointly manage the proposed curriculum. This means that there will need to be guidelines for decision making related to changes to the curriculum. We propose that faculty from each hosting college is involved with curriculum review and that a curriculum committee be established across the university to handle such matters. Due to the systematic process of curricular changes, it will be inefficient to have all curriculum changes go through more than one college curriculum. This is an issue that will need to be discussed. WMU-CHITA has established a community council that will provide a voice of the community and the members will be instrumental in shaping this curriculum to national and international interests.

Capacity

For the first few years, it is likely that the university will have capacity for students in this major. At such time that demand exceeds capacity, new sections of the courses will need to be offered and that may require additional faculty lines. Currently, several courses are cross-listed across the university to help with capacity issues. Cross-listed courses provide us the means to offer on section of a course at a participating college and all students regardless of college membership will be able to register for the course. This action conserves resources. As the demand grows, the cross-listing approach facilitates a means spread the burden of course delivery across the university.

Program Management

In order to meet the guidelines put forth by CAHIIM, the program will need a director who can attend to the program at least half time, and will likely grow to full time. When this issue arises, the hosting colleges and deans will be required to work together to resolve the financial responsibilities of that position.

CONCLUSION

There is no quick fix solution for the problems that are inherent in health care in terms of information management and their accompanying systems. The demand for skilled and knowledgeable professionals in the health informatics and information management areas is growing at an alarming rate. The academic community has a responsibility to offer and provide curriculum that is in line with the current and projected needs of our communities, locally and abroad. The strengths of this curriculum are that promotes interdisciplinary collaboration and cooperation among faculty across the university, the curriculum (in its early stage) is cost and resource efficient, and students will benefit greatly from multiple domain knowledge exposures. Learning the skills and knowledge of this curriculum major will enable students to have leadership positions in many health care areas. It is well understood that what the community needs from our graduates will be continuously shifting due to changes in technologies and methods of doing work. It is our goal to prepare students and shift our curriculum major as the need arises to be leaders in this industry. It is expected that our focus will remain strongly targeted on the content and competencies of this curriculum to make large impacts on our community.

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Guiding Health Care Policy through Applied Public Health Modeling and Simulation

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Abstract: The risk of a widespread epidemic is a primary public health concern with implications for healthcare providers and organizations. Modeling and simulation techniques have been successfully applied at the national level to set governmental policies and mitigation strategies through simulation-based predictions. Existing research in this field has been non-uniform in its coverage of local systems and region-specific findings. New collaborations between on the ground providers and modeling groups are required for successful simulation-based experimentation of region-specific health systems. These proposed collaborations are expected to contribute high-quality sub-population datasets to be used in experiments at the national level and allow for the reuse of existing disease models and simulation infrastructure in support of regional predictive experimentation.

Keywords: Public health, modeling and simulation, policy

INTRODUCTION

The threat of a global epidemic is an important public health concern. The modeling and simulation community has estimated that a pandemic influenza of a size similar to the 1918 Spanish flu outbreak would today result in 150 million deaths and a \$4.4 trillion cost to global economic output (McKibbin 2006). The current state of unpreparedness would lead to overwhelmed health infrastructures and disrupted economies. This threat highlights the importance of incident response and policy at regional, statewide, national, and global levels. Public health planners at multiple levels of governance require methods to set planning strategies and predict the expected impacts of policies. Computational epidemiology is a field that studies the health of populations and spread of diseases. Modeling and simulation research groups in this community can help local clinics and regional hospitals in setting policies during an epidemic.

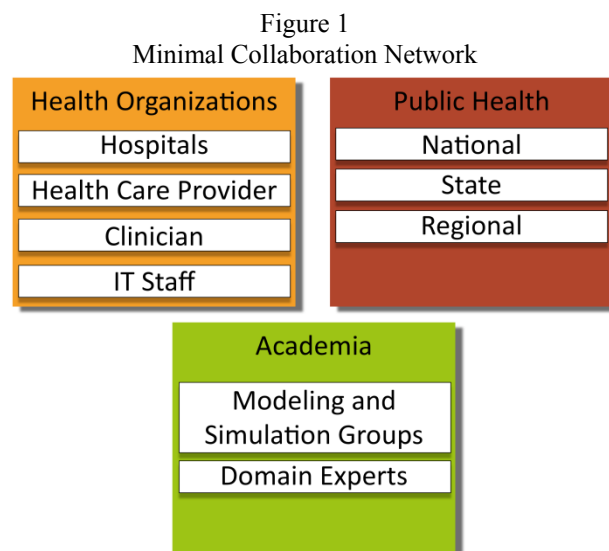
Public health officials at the federal level rely on simulation-based findings by computational epidemiology researchers to set public policies. Disease models, social networks, individual behavior models, public policies, and simulation systems are typically used to predict the effects of potential mitigation strategies on the course of a disease. Simulation-based experimentation can provide guidelines for public antiviral and vaccine distribution, private prophylactic use recommendations, distribution of pharmaceutical kits to selective groups (e.g., health care workers and children), individual behavior recommendations (e.g., masks, social distancing, staying home, and sequestration of the infected), hospital and healthcare utilization predictions, and community recommendations (e.g., local event and public school closures). The analysis of possible policies in these areas currently provides support for how to allocate resources, distribute pharmaceutical kits, minimize anticipated costs, and mitigate the spread of contagions at the national level.

Similar efforts are needed to produce a body of scientific work to support various public health strategies and decisions at the local level. Specifically, best practices are needed to improve local health policies and to scientifically predict possible effects of decisions. Collaborations between simulation research groups and local healthcare experts are necessary to guide the regional priorities and strategies of public health and clinical systems.

PROJECTS AND SOFTWARE TOOLS

The development of epidemiology models and simulation applications requires the expertise of disease modelers, computational scientists, medical practitioners, public health officials, statisticians, mathematicians, physicists, and entomologists. Disease models, simulation software, and computational infrastructure are produced from extensive development efforts that are costly to duplicate between research groups. Designing and executing experimental studies using simulation and analysis software requires in depth knowledge of a particular simulation model and technical expertise. When done correctly, a simulation infrastructure and experimentation workflow may be used to predict the effects, cost, and plausibility of healthcare strategies. Several research groups have epidemiology simulation systems in place for experimentation at the level of regional, national, and worldwide scenarios. With currently available disease modeling applications, new studies must increasingly be conducted by area experts with detailed knowledge of local populations and available resources. To conduct simulation-based experimentation leading to real-world policy impacts, collaborations are needed between medical experts at health organizations, modeling and simulation research groups in academia, and governmental public health agencies, shown in Figure 1.

A large body of existing tools and research exists in computational epidemiology. Disease models and simulation applications have been developed with support from organizations such as NIH Models of Infectious Disease Agent Study (MIDAS) and the Bill and Melinda Gates Foundation. The public health modeling community has developed numerous modeling and decision-making tools using distributed agent-based models and differential equations. These models have been used extensively in previous work to set policies for agencies including CDC, NIH, DOD, WHO, and the White House.



The diverse nature of vector-borne, contagious, and sexually transmitted disease models require specialized simulation applications. Two notable applications are FluTE, a stochastic influenza epidemic simulation model (Chao 2010), and OpenMalaria, a publicly available malaria simulation model (Smith 2006). Modeling and simulation techniques have been used at the Network Dynamics and Simulation Science Laboratory (NDSSL) to study the spread of diseases such as H1N1, H5N1, malaria, smallpox, and pertussis (whooping cough).

Public health researchers and officials have used NDSSL's existing simulation applications to determine optimal vaccine and antiviral distribution strategies, treatment and prophylaxis policies, targeted sub-populations, and dose guidelines. These applications have also been used to set policies for school and work closures, isolation of infected individuals, social distancing recommendation, public and sporting event closures, pharmaceutical kit selection, recommended family interactions, and potential public campaigns (e.g., hand washing, travel guidelines, and mask usage). The following are a representative sample of five isolated studies that have included local health case-reports and survey data in simulation-based studies of H1N1.

In Cauchemez (2009), data were collected from state and local health department case-reports. These reports included applicable clinical symptoms and demographic information of infected individuals. This tracking information was used in modeling the disease, how it spread, and provided recommendations for families with infected members.

Cauchemez (2011) demonstrates how models of local populations can be used in larger scale predictions. This study tracked the spread of infections starting in an elementary school in a semirural community in Pennsylvania. The school and community social networks were analyzed. The analyses lead to the development of transmission models to be used in future studies on the prediction of transmission considering targeted treatments.

Donnelly (2011) consists of analyses covering several local studies of H1N1 cases. The set of local studies includes staff, pupils, and family members associated with the New York City school system, a southeastern Pennsylvania school system, San Antonio high schools, and Houston school system. The study also included cases from an agricultural county on the Mexican border (Imperial County, California) and CDC national case-reports. This comprehensive study determined a recommended duration of isolation for infected individuals to reduce the onward transmission in future epidemics. These recommendations, along with recommendations for similar issues (e.g., school closures), feed into parameter calibrations of ongoing and future simulation studies.

In Chao (2011), simulation models were used to predict the seasonal timing and magnitude of epidemics in Los Angeles County. The study aimed to also predict the effects of public campaigns and timing of subsequent waves of infection. The results of the study provided a basis for developing appropriate response policies in Los Angeles public health departments and clinics.

Matrait (2010) is composed of a traditional comparison of vaccine allocation strategies. The findings of this study serve as a guideline for public health planners and services providers. The results detail which groups to treat with available resources and when to optimally distribute pharmaceutical kits during an epidemic.

The disease models and simulation infrastructure utilized by NDSSL are based on disaggregated agent-based network diffusion processes, now a *de facto* approach within the simulation community. The set of simulation tools produced by NDSSL includes EpiSimdemics public health disease modeling and simulation system (Barrett 2008), the EpiFast epidemiology simulation system (Bisset 2009), and the ENteric Immunity SIMulator (ENISI) immunopathology modeling system (Wendelsdorf 2010). Over a dozen studies using these tools have been conducted at the national, statewide, city, and regional levels on behalf of several governmental agencies. These studies, at the granularity of individual persons, have included predictions of the spread of influenza through military and civilian populations in Alabama (pop. 4,600,000) as well as the spread of smallpox in Portland (Barrett 2005). Two related studies investigated the interaction between public and private behavior (Barrett 2009), as well as the infection and socio-economical impact of mitigation strategies based on individual demographics (Barrett 2011). The study presented in Barrett (2011) was conducted on the New River Valley (NRV) region in rural southwest Virginia (pop. 151,000). ENISI has been used to predict the inflammation and regulatory immune pathways considering interactions between individual cells and foreign bacteria in tissues such as the gut. The model is used by mucosal immunologists to test hypothesized mechanisms for predicting clinical enteric disease outcomes.

The current set of state-of-the-art modeling and simulation tools are widely missing local clinical information for most regions in the U.S. The few areas in the country with real world, high-resolution data on local health systems are generally located in the region immediately encompassing a modeling and simulation research group (e.g., Virginia Tech and University of Pittsburgh). Increasing the collaboration between research groups, clinicians, and area health providers would improve large-scale predictions as well as enable research in setting policies specific to a given area. As an example, information on a regional hospital's expected occupancy, capacity, staffing, patient throughput, and medicinal resources would greatly increase the accuracy and validation of simulated predictions that lead to the recommendations presented to health officials and providers.

OPPORTUNITIES FOR HEALTH CARE DELIVERY

Predictive simulations play an important role in setting public policies and now provide an opportunity to optimize practical health care delivery. Hospital modeling, health provider infrastructure modeling, local population

modeling, and incident tracking are missing components in current public health research efforts. Systematic collaborations are currently needed between modelers and hospital IT staff to produce a comprehensive set of hospital and health provider models. These models would ideally be structured into a framework along with disease modeling and simulation systems to assist providers in disaster preparation. Specifically, the composition of disease and health provider models provide predictions on staff overload, resource shortages, capacity requirements, and patient routing during a disaster scenario. In some cases, these simulations also may be used to guide clinicians and practitioners in delivery activities based on the predicted high-impact procedures. Simulations also assist in non-medicinal planning by guiding recommendations that reduce the stress on health systems such as private behavior modifications, preventative measures, insecticide usage, and bed-netting usage (in tropical locations). Higher-resolution information on individual regions, when agglomerated at the national level, may be used to provide pertinent local public health recommendations while improving the accuracy of national studies. Littig (2007) provides a case study of the impact modeling can have on producing accurate predictions and advanced knowledge forecasts for future hospital occupancy and service requirements. This study used historical data from an area hospital to model inpatient census, occupancy by unit and shift, resource use and fluctuation, staffing requirements, bed management, ambulance diversions, and patient care quality. Including this information in disaster simulations provides predictions and suggestions on current areas of a health infrastructure that need improvement. The computing infrastructure provided by modeling and simulation research groups also eases communication and dissemination of findings to rural and poor regions and provides a central medium of reviewing previous studies; see SimDL, a simulation-supporting digital library (Leidig 2011). SimDL has been developed for the purpose of managing the underlying datasets, disease models, population models, experimental designs, study results, analyses, and publications for research produced through simulation systems. This digital library services as a portal for collaborations between healthcare providers who are contributing information on local health infrastructure and modelers, software developers, analysts, and public health officials. SimDL also serves as an access point for hospital managers, providers, and IT staff to discover recent predictive studies and recommended disaster planning policies. Previous experiences in malaria research have showcased the mutual benefits of collaborations between modeling research groups and area health providers; see Swiss Tropical Institute (Switzerland) and Ifakara Health Institute (Tanzania). While there are current epidemic surveillance and mitigation systems in place by state and national authorities, there is disappointingly little collaboration between public health researchers and health providers in setting epidemic-related policies.

ROLE OF THE HEALTH CARE PROVIDER AND IT PROFESSIONAL

The potential of intelligent disease modeling and mitigation will only be realized through the emergence of collaborations between health providers, provider IT staff, clinicians, modeling and simulation groups, and public health officials at all levels of government. Efforts by health care and IT professionals are needed to provide local datasets that will improve national and local health care modeling. By contributing data on local health systems, the accuracy and quality of health model are improved at the national level. In addition, this data can be used in micro-simulations that use existing high-quality simulation applications. By restricting the scope of the simulations to use only locally provided datasets, local health system planners receive access to previously unavailable simulation-based predictions and analysis of their systems. IT staff will need to play a significant role in providing anonymous and summarized patient data to modelers while adhering to internal privacy requirements. In the reverse direction, IT professionals will need to review predictions, made by the modeling community, of hospital utilization during a disaster in order for members of management to set internal policies. IT staff also play a role in the early identification and reporting of emerging diseases and epidemics through data organization and mining practices. The reporting of detailed inpatient modeling, similar to Littig (2007), in addition to published surveillance data by NIH and CDC, are necessary for the modeling community to conduct accurate simulation-based experimentation. Improving the quality and resolution of datasets used by existing modeling tools directly benefits health providers. The products of modeling tools are currently being used to set national policies, as previously discussed, and will provide a new class of simulation-supported findings in how health care providers should optimally utilize resources and recommend behavior modifications to patients (e.g., out-patient sequestering).

NDSSL's existing modeling and simulation software applications have been developed to execute on large-scale computing resources. These applications are capable of handling multiple disease models and underlying population data. New disease models and healthcare system models, when formatted correctly, may be directly utilized without any modifications to the simulation software. SimDL provides a point for storing and managing models of

healthcare systems and the population each system supports. Each modeling and simulation group has developed custom formats for describing healthcare and population models. Unfortunately, model formats are currently incompatible between modeling research groups, although there have been some efforts to standardize and translate between formats. Direct collaborations are needed between individual healthcare providers and modeling groups to produce a new class healthcare models. NDSSL has previously produced population models based on census data and activity modeling. Individuals in these synthetic populations are attached with demographic information (e.g., age, income level, address, family size, and daily schedule). To produce a model of a healthcare provider, modelers and healthcare providing organizations must provide information related to descriptive capabilities (e.g., beds, staffing, and resources), usage history (e.g., baseline unit utilization and throughput), and the population served (selected as a subset of the existing U.S. population model).

Previous collaborations between several state health departments and the modeling community have successfully produced tools (e.g., simulation visualizations) that rely on hospital data and population information to inform disaster planning decision-making at the state level. In domains supported by computing efforts, data collected for one purpose may often be reused later in different contexts. The prediction and optimization uses of inpatient data along with hospital and provider capability modeling may have beneficial, currently unforeseen public health uses (e.g., tracking infections within a hospital). As a caveat learned from decisions at the national level, analysts at health providing organizations would do well to remember that setting antiviral and vaccine purchasing and distribution policies based on simulation studies must consider healthcare imperfections such as waste, misuse, and misdiagnosis.

CONCLUSIONS

Computational epidemiology modeling and simulation research has been extensively used to set national public health policies. Data and models covering the health systems, capabilities, and anticipated needs of local regions are generally unavailable. Higher resolution simulation-based experiments will require the widespread availability of regional healthcare system datasets. Several existing studies have shown the benefits these datasets have on predictions for multiple infrastructure planning and policy issues. Previous high-quality, high-performance simulation systems have required large amounts of federal and private funding. Development of state or regionally specific simulation infrastructures is unsustainable and impractical. Existing simulation tools may be made available to local planners and health care providers, given mutual collaborations in the experimentation process. To get involved in disaster planning and resource optimization processes, healthcare providers will need to contribute models of local health systems. These regional models of health systems and usage statistics may be plugged into existing public health simulation systems. The authors call for future systematic collaborations between health providers and leading simulation groups with previous experience in modeling health systems the national level.

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Health and Information Technology

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Abstract: The healthcare industry continues to grow to meet demands of a changing environment and a growing number of people. Moreover, the Information Technology space continues to expand to meet customer's needs and the continuing desire of people and companies to be the most technologically advanced. In order to allow the healthcare industry [or any industry] to continue to grow, it has to allow itself to expand with technology to help serve its customers more effectively. Through this partnership, it is possible for healthcare to become something more to its customers through more efficient and effective healthcare management.

INTRODUCTION

A growing trend shown in many larger companies is empowering the employee (or individual) to manage their own healthcare with support from other resources. The biggest, and probably most significant change, is the ability for the individual to manage their health by leveraging technology. With the substantial advancements in online access to an enormous amount of information, individuals now can start using technology as a basis for their health care management. As shown with other various online activities such as online banking, shopping, and even social networking; it only encourages the fact that healthcare can operate in the same way.

Empowering the Individual

If we emulate what some corporations have done by allowing their employees to manage their healthcare, primarily their "health stats" online, it achieves multiple objectives. First, with information being accessible online by the individual, it allows them to stay more engaged with their on-going health. In addition, the ability to access that information easily makes the user more likely to stay engaged as opposed to a "once and done" attitude that many people take with annual screenings. Another opportunity is the growing trend for an all-inclusive site that houses related information. It is this particular point that could add the most value. Considering the many sites that allow people to manage their various online banking accounts via one site, such as *my247* or *Discover Card*, we can see the powerful nature of such a site that can draw the individual's interest to manage things online.

As many of us have experienced, the on-going acceptance of I.T.-related advancements can be sporadic and even fail because of the ability for the individuals to understand the benefits or the technology. If we think about the number of passwords that one individual has to remember to access all of their online accounts, it is easy to see why having one more online account (such as healthcare) might not be widely accepted. However, if we can move towards a single repository for information that the individual can access and manage [with restrictions to information updated by hospitals or professionals], then we open up the ability to start leveraging technology to advance the healthcare field even further.

Let us imagine a time where an individual can have access to the aforementioned information. A time where someone can say, "when was my last check-up" or "what was my blood pressure back in April" and be able to access that information through a health portal. Technology in 2011 has the ability to allow individuals to have such access and be able to manage their lives more efficiently. As with any technology, there would be an acceptance period and a learning curve, but as the business sector has shown us, people like to have access to this information. Let us take one particular example where a business has taken online access to make an individual's life easier. PNC bank has recently released a revamped website that leverages technology to help individuals manage their finances more effectively. They are using calendars and analysis tools to allow people to track their expenses and income and then sort by the day and by type, transaction, or even amount. Many other companies are using such online tools

because they recognize there is a demand for it and that it helps people manage themselves more effectively. Technology can help us apply this same concept to more health-related information.

Caregiver Visibility

It is a tragic situation when someone needs 24/7 care in a hospital or in their own house for many different reasons. Caregivers, especially those in Hospice, have a special role in not only taking care of the individual but the family as well. If technology can help the caregiver provide more support to the individuals involved, then healthcare can advance with new opportunities.

When an individual is getting around-the-clock care, there are many family members and friends that are interested in the progress of the individual and would also like periodic updates. If technology can empower the caregiver to update online information that allows friends and family [with secured access] to get updates on their loved-ones, then maybe the caregiver can be even more effective. Although situations can be traumatic, having a “scorecard” or some kind of graph that shows the person’s progress could help friends and family keep up-to-date without actually being at the location. With increased travel and more remote meetings, it would make sense that healthcare have the ability to operate in the same way. If we then couple the updates with places for people to blog or write notes to the individual, then technology is not just helping the caregiver and loved-ones, but the patient as well.

Certainly online updates can be a two-way street; they can be as used or unused as individuals see fit. The most important part is that technology can provide that option or access to allow people to decide on how to be involved. It is this type of technology that empowers that gets the highest rate of acceptance from people. In this way, healthcare can then transform into something more than just help but support to anyone that chooses it.

Analysis in Healthcare

Although it may already exist in some form now, the ability for doctors, hospitals, and even individuals to analyze trends in diseases, check-ups, and even information is limited at best. With the advancements in the business intelligence space, there are opportunities for the healthcare industry and the private sector to start analyzing data to discover trends.

Preparation is always the best precursor to any big activity but the information to help preparation is not always available or accurate. By leveraging technology, hospitals and doctors can begin collecting data to help analyze emerging trends in the local or regional environment. If these entities had an efficient, easy-to-use way of collecting, analyzing, and using this data, they can try to get ahead of pandemics or other outbreaks. Although this idea is already in place at a lower level, it is not necessarily tied to a particular area, hospital, or even region. As we try to prepare for the future, having the ability to recognize a growing trend in a particular disease or virus could potentially help limit the environment’s exposure to it.

With all of the new programs and tools that are available for analyzing data and trends, the ability for local hospitals, doctors, and individuals to understand emerging trends should be easier than it was in the past. In many cases, when leveraging business intelligent software, there is very little, if any interaction from the user; other than reading the report. Technology can help make the data that is collected more valuable while still providing value to those people that want to leverage it. As the environment grows in a particular area, the ability to handle and understand the increased data becomes that more important. If we utilize technology to its potential, we can help achieve these objectives while still providing superior service to our customers.

Final Thought

The healthcare industry is constantly growing and advancing in order to help people and sustain the environment. Technology can present a unique opportunity for the healthcare industry to become even more efficient than they are

now. Although there is more technology available that could ever be used by any industry, the ability for technology to impact healthcare from many levels makes it a strategic-need rather than a nice-to-have.

By leveraging technology and some of the ideas mentioned above, any healthcare industry, from a local doctor's office to a large regional hospital, can help treat their patients and customers more effectively while still maintaining a high level of service. Just as businesses need to grow and stay current to survive, the healthcare industry needs to evolve as much [if not more] to adequately meet the demands of the environment. As long as the impact of the technology does not deter from the spirit of the industry, it can become a very effective symbiotic relationship that can help drive more effective and efficient process. This, at the end of the day, is why we choose to advance in the first place.

The Active Bundle Scheme for Protecting Electronic Medical Records

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Abstract: Adoption of the electronic medical records (EMRs) or electronic health records (EHRs) by healthcare providers will improve the quality of the American healthcare and reduce the annual bill. However, it will also increase privacy threats due to easier dissemination of EMRs/EHRs than “paper” medical records. Current privacy protection solutions for patient EMRs/EHRs have two main limitations: (1) they require an extensive exchange of messages between computer systems of healthcare providers; and (2) they depend only on data encryption.

In this position paper, we propose a solution that provides protection for the patients' EMRs/EHRs disseminated among different authorized healthcare provider systems. This is achieved through the use of the construct named *active bundles* (ABs). ABs keep EMRs/EHRs as *sensitive data*, include *metadata* containing privacy policies, and encompass a *virtual machine* that enforces privacy policies.

Keywords: Active bundle, Electronic Health Record (EHR), Electronic Medical Record (EMR), Patient's confidentiality, Patient's privacy, Privacy policy.

INTRODUCTION

Exchange of patient data among healthcare provider systems is a factor necessary for improving the quality of healthcare. It is being facilitated by the expansion of information technology applications. Examples of *healthcare providers* include: physicians, surgeons, dentists, pharmacists, nurses, etc., as well as the organizations employing them.

Medical records are an account of patients' long-term health history, which contains medical history, prognoses, laboratory and radiology tests, treatment descriptions, etc. Medical records have been passing through technological transformation from a physical folder form to a digital form since the end of the last century.

Electronic Medical Records (EMRs) are different from *Electronic Health Records (EHRs)* in terms of interoperability of medical information (Garets & Davis, 2006); EMRs are legal records of patients that are created in a single healthcare provider facility like a hospital or a clinic, while EHRs are the summaries of EMRs collected from more than one healthcare provider that a patient has visited. EMRs/EHRs have similar goals: (1) improving safety, quality, and efficiency of patient care; (2) reducing the cost of healthcare provider delivery; and (3) enriching the health-services research and public health monitoring (Hall, 2010). To save space, we will use the term “EMR” while in the vast majority of cases we mean “EMR/EHR.”

A patient has the right to read his EMR, but he has no right to modify part(s) of information in his EMR, especially records that are related to the healthcare provider, for example, a physician's diagnosis and treatment. On the other hand, a physician has the right to read these records and no right to modify personal patient information like address and contact information.

The *ownership* of an EMR, like the ownership of any property, should represent the state or fact of exclusive legal rights and control over the property. We define a *legal guardian for an EMR* as a person or institution who has the legal authority (and the corresponding duty) to care for the patient's EMR in terms of issuing permissions for creating, reading, or modifying the EMR.

The ownership of EMRs is a central issue in healthcare because medical information has a commercial value; for example, some companies are making a profit by selling physician's prescribing routine to pharmaceutical companies (Benaloh, Chase, Horvitz & Lauter, 2009). According to American Medical Association (AMA), healthcare providers own the medical information that they are collecting (Hall, 2010) while federal and state privacy law and the Health Insurance Portability and Accountability Act (HIPAA) regulations guarantee the protection of a patient's privacy through the control of sharing the patients' healthcare information among healthcare providers. In addition to being accessed by healthcare providers, EMRs are also reviewed by many other parties, such as health insurance companies and federal or state governments. As the result, neither the ownership nor the guardianship gives the patient complete rights over the patient's EMR.

Among all these challenges along with what future government plans introduce, patients' privacy and confidentiality are considered important topics by many researchers. We define *privacy* as "the right of an entity, acting in its own behalf, to determine the degree to which it will interact with its environment, including the degree to which the entity is willing to share information about itself with others" (Shirey, 2000). *Patient privacy* refers to the patient's right to keep and control their health information. Patients determine when, how and which portions of their health information are disclosed or disseminated (Patient confidentiality, Encyclopedia of surgery, 2011). Patient confidentiality is the right of a patient to keep his healthcare or medical information private and confidential unless the patient gives permission to disclose it to another party. We believe that patient privacy or patient confidentiality gains in importance because there is a risk that patients' personal or private information (such as the social security number, or home address) might be disclosed during interactions among healthcare provider systems or other systems authorized to access it.

The goal of this position paper is arguing that an active bundle scheme can protect privacy of patients by protecting their EMRs.

BASIC CONCEPTS OF THE ACTIVE BUNDLE SCHEME

An active bundle or AB (Ben Othmane & Lilien, 2009) is a software construct, which bundles together the following three components: (1) *sensitive data*, which can contain a patient's EMR, so it is protected from privacy violations (2) *metadata*, which contain information describing sensitive data and prescribing its use; they include a privacy policy for the sensitive data (which control the access to sensitive data or their portions), as well as the rules for AB dissemination; and (3) Virtual Machine (VM), which controls and manages how its AB behaves, thus making the AB active; the essential task of the VM is enforcement of the privacy policy specified by metadata (Ben Othmane, 2010; Ben Othmane & Lilien, 2009).

In more detail, there are four protection mechanisms that the VM provides on behalf of its AB:

- 1) Enforcing privacy policies: Allows a host to access all or a part of the sensitive data according to the privacy policy specified in metadata.
- 2) Integrity checks: Verify integrity of data, metadata, and the VM of an AB. When a check fails, the VM can evaporate the bad data, or apoptosize (self-destruct) its AB (Ben Othmane, 2010).
- 3) Apoptosis: Destroys irretrievably the *entire* AB (including its data, metadata, and VM) in cases when: (1) a visited host's trust level is lower than the required trust threshold specified by the privacy policy; or (2) the integrity check fails.
- 4) Evaporation: Destroys irretrievably a *part* of the sensitive data that the visited host is not authorized to access. Typically, evaporation destroys all AB data with the "required trust level" *above* the trust level of the visited host (no metadata or VM code is affected); only less sensitive data (that a host with a lower trust level may access) remain.

Delivering sensitive data to a destination host involves two processing steps. First, during AB *creation* an active bundle encapsulates its EMR (sensitive data), metadata, and the VM. A created AB becomes ready to be sent to a destination (carrying its EMR). Second, when an AB reaches its destination (a visited host), the AB's *enabling* process starts; Enabling includes enforcing privacy policies (by the AB's VM), followed by obtaining the visited

host's trust level, then performing (by the VM) the appropriate subset (as specified by the AB's privacy policy) of the apoptosis, integrity checking, evaporation, and data disclosure data activities.

The current implementation of the AB scheme (Ben Othmane, 2010) uses Trusted Third Parties (TTPs) for maintaining (and providing to ABs) the trust levels of visited hosts.

LITERATURE REVIEW

Due to space limitation, we present related work very concisely. Bhattacharya *et al.* (2006) proposes a middleware architecture called {Privacy Broker} to enforce the legal privacy requirements. It uses: (1) a unique key to encrypt and decrypt data that it retrieves from a database and (2) capability certificates that verify and evaluate all users' requests and enforce policies to access patient's data.

Benaloh *et al.* (2009) propose an encryption system, called Patient Controlled Encryption (PCE), to protect patient privacy. Using the PCE, the patient controls and shares his EMR with other authorized entities through generating and distributing a set of subkeys.

Akinyele *et al.* (2010) suggest using a self-protecting EMR inside and outside of the hospital environment. The solution uses attribute-based encryption and a cloud system. The solution uses a set of policies and encryption/decryption keys that allow a patient: (1) to read his Personal Health Record (PHR); and (2) to read, write and manage his EMR through his mobile device that interfaces with a cloud system such as Google Health.

PROBLEM STATEMENT AND RESEARCH HYPOTHESIS

Protecting patient privacy is considered the main problem in healthcare information technology and healthcare informatics. The current solutions for protecting patient EMRs have two main limitations: (1) they require not only an extensive exchange of messages between caregivers to protect data, but also exchange of numerous control messages among caregivers' systems; and (2) they depend only on encryption (in which data decryption keys must be provided to specific caregivers).

In contrast, the AB scheme eliminates both limitations. First, it does not require so many control messages between the AB and the visited host in order to deliver an EMR from a source to a destination. Second, the AB scheme protects privacy of data not only by encryption but also by enforcement of privacy policies. Additionally, our approach does not need to distribute decryption keys (which are typically used in other privacy solutions) for all authorized healthcare providers; instead AB relies on TTP that provides the decryption keys.

Multiple *versions* of an EMR, with different owners (or guardians), can exist for a single patient. Multiple versions are generated when the EMR creator does not know that another EMR exists, or when the EMR creator is unable to receive a copy of an existing EMR. Multiple versions can also stem from a single "initial" EMR in the process of its dissemination and updating.

An EMR updated by multiple entities becomes *multi-owned*, that is, its different portions (even its individual records) are owned by different entities. This happens when an EMR is disseminated among guardians, and a receiving guardian updates its own EMR with information from the received EMR; information used for the update was created (and is owned) by the owner of the received EMR. Multi-owned EMRs can overlap (two EMRs *overlap* when both include at least one record owned by the same owner.)

There are a few issues related to multiple versions and multi-ownership of EMRs. First, the vagueness of EMR ownership rights and limitations of federal and state privacy regulations give strong reason for EMR owners to isolate and avoid sharing their EMRs (Hall, 2010; Jha *et al.*, 2009). Second, an owner lacks tools to protect patient's privacy rights for arbitrary EMR fragments (down to the single record level) owned by him. Third, given a set of

owners of a patient's EMR, a rational attacker will facilitate his attack by requesting the EMR from the owner with the most lax privacy policies (of course, EMRs obtained from different owners might differ).

AB provides solutions for the above issues as well. First, the EMR owners using ABs do not have to isolate EMRs or avoid sharing them because ABs prevent unauthorized EMR accesses by visited hosts with insufficient trust levels. Second, ABs provide tools protecting owners' (or guardians') privacy rights for arbitrary EMR fragments (down to the single record level).

Third, AB protects a patient's EMR even if the EMR is owned by different owners with privacy policies of differing strength. Even if an attacker tries to exploit the laxness of some owners' privacy policies, he still faces the AB's VM that enforces the required level of privacy via AB's privacy policies.

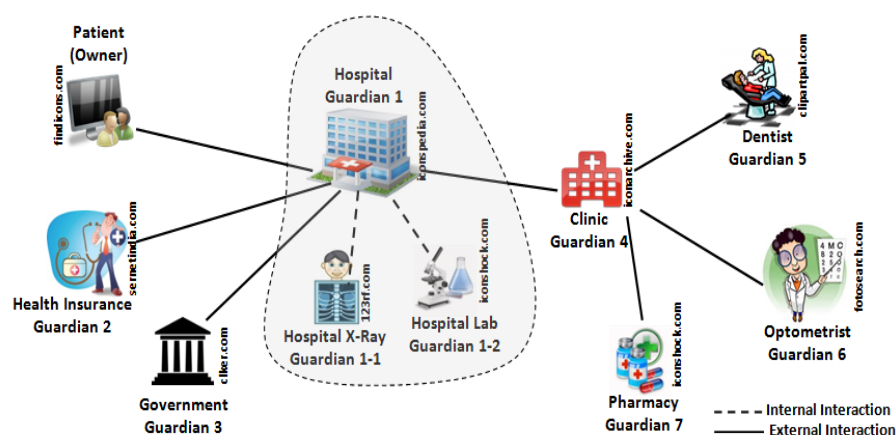


Figure 1: EMR dissemination.

Figure 1 illustrates an EMR dissemination. The hospital represents the main guardian for a patient's EMR. The hospital might send a copy of the patient's EMR to other guardians. For example, a clinic (Guardian 4) receives from the hospital and keeps a copy of a patient's EMR before, during, or after his visit. The patient's EMR is updated by multiple guardians, which increases the risk of its disclosure to unauthorized parties.

Our hypothesis is that the active bundle (AB) scheme can protect a patient's EMR during its entire lifetime; in particular, the AB scheme can prevent the EMR privacy problems discussed above.

THE PROPOSED SOLUTION: USING AB FOR PROTECTION OF PATIENTS' EMRS

Figure 3 shows a basic scenario for a patient visiting a clinic for the first time while his most up-to-date EMR is located in the general hospital that he usually visits.

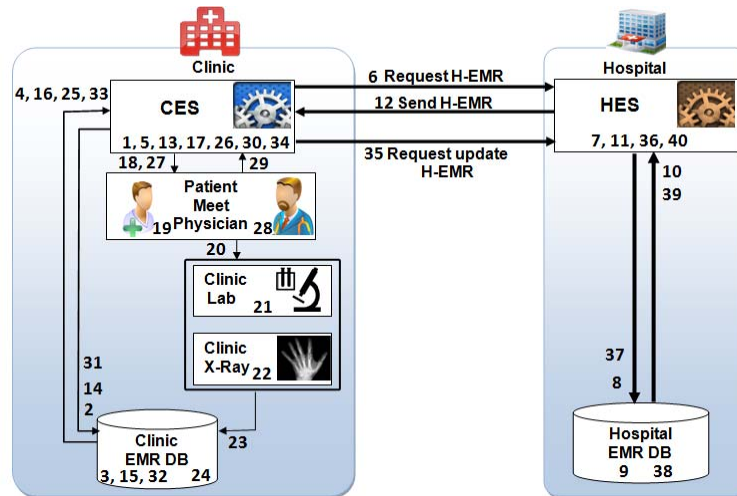


Figure 2: A patient visits a new clinic.

The scenario starts at the clinic EMR system (*CES*) with the local request (Step 1) for the patient's EMR from the *CES*'s database. Because this is a new patient, the database fails to find C-EMR, that is, the patient's EMR for the clinic (Steps 2, 3 & 4). After realizing that there is no record for the patient (Step 5), the *CES* sends a request for a patient's H-EMR, that is, his EMR from his hospital EMR system (*HES*), (Steps 6). The *HES* receives the *CES*'s request and sends a local request to the *HES*'s database. After finding the patient's H-EMR (Steps 8, 9, & 10), the *HES* sends back the patient's H-EMR to the *CES* (Step 10). The *CES* receives the patient's H-EMR (Step 12) and uses it to create the patient's C-EMR in the *CES*'s database (Steps 13, 14, 15 & 16). Then, the *CES* sends the C-EMR to the clinic's physician (Steps 17 & 18). The C-EMR is available for the physician's review (Step 19). The physician meets the patient in her office in the clinic to diagnose him. The physician requests tests from the clinic's laboratories or the X-Ray department (Step 20). New records (requests for tests) are created and sent immediately to the *CES* database (Steps 21 & 22), which updates the patient's C-EMR (Step 24). Then, the tests results are posted to *CES* database for updating (Step 23). The patient's C-EMR is updated (Step 24) and sent (Step 25) to the *CES*, which processes it (Step 26). The physician is notified when the patient's test results are available (Step 26). She can now review the test results (Steps 27 & 28), and make her decision about the patient's case; for example, she finds that the patient must be seen by a surgeon in his hospital. The physician gives his instructions to his nurse who adds them to the patient's C-EMR (Steps 29, 30). The nurse schedules an appointment for the patient with a surgeon in the hospital and includes that in patient C-EMR. The *CES* updates the patient's C-EMR (including the surgeon's appointment information) in the *CES* database (Steps 31, 32, 33, 34). The *CES* sends the up-to-date patient's C-EMR to the *HES* (Step 35), which uses it to update the patient's H-EMR (Steps 36, 37, 38, 39 & 40). The scenario for Figure 2 ends when the *HES* receives a notification that the H-EMR update is completed (Step 40).

The patients' EMR in the above scenario can be protected by using an AB encapsulating the patient's EMR. Both the *CES* and *HES* can send and receive the AB containing the patient's EMRs (its H-EMR and C-EMR versions). Figure 3 shows high-level structure of the AB scheme that provides the lifetime protection of the patient's EMR, from its creation until its destruction.

In detail, an AB is created and enabled as follows. An AB created in the *HES* packages a copy of patient's H-EMR as sensitive data, the associated privacy policy as metadata, and an executable code as VM (each component of the AB can be encrypted). The decryption keys for the AB are sent to a TTP for secure management. The AB is now ready for dissemination. In particular, it is ready for being sent from *HES* to *CES* when a request from the *CES* arrives (as shown in Step 6 in Figure 2). Once the AB is received by the *CES* (on the visited host), it can be enabled at the *CES*, as shown in Figure 3. Enabling starts with the AB's VM enforcing privacy policies to evaluate the *CES* credentials, and deciding which (if any) EMR portion from the received H-EMR may be disclosed. The VM uses a TTP to obtain the trust level of the *CES*. The TTP provides the decryption keys to the AB's VM only if *CES* has an adequate trust level for accessing at least data portion of the EMR.

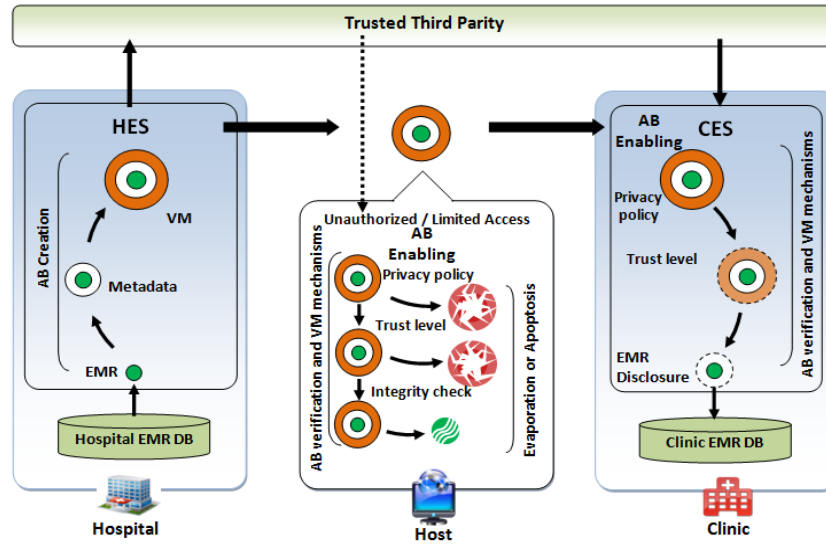


Figure 3: The AB protection lifecycle for a patient's EMR.

During AB enabling (Ben Othmane, 2010; Ben Othmane & Lilien, 2009), the CES is allowed to access only the data made accessible to it by the privacy policy-according to the following verifications steps: (1) *Evaluate visited host's trust level*: A TTP certifies the CES's trust level. The CES can access all or part of the patient EMR (sensitive data) only if its trust level is not lower than the threshold trust level specified by the privacy policy; and (2) *Run AB's integrity check*: The integrity check, specified in the metadata and VM, verifies AB's integrity. It compares the computed AB's hash value with the expected AB's hash value provided within metadata. Depending on the results of the above verification steps, VM performs one or more of the following activities on the AB under verification and on its EMR (Ben Othmane, 2010; Ben Othmane & Lilien, 2009) as shown in Figure 3: (1) apoptosis, (2) evaporation, or (3) data disclosure.

CONCLUSIONS, WORK STATUS AND FUTURE WORK

We propose a solution that provides protection for the patients' EMR during entire EMR lifetime, including its dissemination among different healthcare provider locations. We argue that this can be achieved through the use of the active bundle (AB) scheme.

Presently, we are working on validating the proposed approach via a simulation. We are also investigating whether our solution can fit into the legacy EMR-processing software. Finally, we will investigate building software that will allow each patient's control over her EMR.

There are many other issues left for longer-term research, including the following ones: (1) developing an AB scheme that does not rely on TTPs (Ben Othmane, 2010); in particular, developing an Agent-Based Active Bundle Scheme (ABABS) to protect privacy and confidentiality for both patient and healthcare provider; (2) improving the current AB scheme to include an automatic trust negotiation that prevents information leaks during credential exchanges; (3) making the intelligent agents supporting ABs able to interact with other intelligent agents (incl. other ABs) and smart healthcare environments (Salih, 2011); (4) investigating the use of the AB mechanism to protect patients' privacy in public and private cloud computing for healthcare; and (5) investigating enhancements of the self-protection level in the AB scheme.

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CHANGING HEALTH CARE BUSINESS MODELS AND COSTS

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Abstract: Changing the health care system has universal support in principal, but has proven contentious in practice. This paper draws upon the theories and publications of three leading business thinkers, and the frameworks they developed for applying business practices to the health care industry: Drs. Clayton Christensen, Robert Kaplan, and Michael Porter of Harvard University. It reviews the disruption theories of Christensen as he has applied them to the health care industry, and connects them with medical costing recommendations of Kaplan and Porter. Two possible disruption possibilities for clinical care and venue are presented.

INTRODUCTION

The challenges of affordable health care in the United States are well publicized. Debate involving the Affordable Health Care Act of 2010 played out for nearly a year, and barely civil confrontations among groups with differing opinions were shown to millions on television. Even now there is an entire political segment intent on repealing the act. Health care costs exceed 17 percent of GDP and continue to rise (Kaplan & Porter, 2011, p. 4). Net healthcare spending by the Federal government alone from 2012 to 2021 is currently estimated at more than a trillion dollars (Elmendorf, 2011). Everyone agrees that the health care system needs re-engineering, but there is no consensus for a re-engineering process. The process that has come closest to consensus is the application of efficiency and effectiveness tools of industrial improvement to the health care industry. This has proven to be a very difficult undertaking. The health care system is so vast, and touches so many people and organizations that those that benefit from the status quo will be very reluctant to support reform unless they judge that their positions will not be compromised. There are substantial legal consequences for unsatisfactory patient outcomes. Physicians, insurers, lawyers, legislatures, and businesses must agree on a framework for reform, and their interests will not necessarily coincide. This paper discusses a framework proposed by Christensen, Kaplan, and Porter dealing specifically with applying the patterns of industrial innovation to health care.

From Niche Markets to Mass Consumption

Historically, the products and services of emerging industries were available to an elite group that had means of access. Early in the development of telephones, photography, automobiles, air travel, and computers only individuals or organizations of substantial wealth could afford them, but eventually these industries were made accessible to large numbers of people through technology, business model innovation, and value networks (Christensen, 2009, pp. xix-xx). With industrial maturity, dependence upon highly trained intuitive experts gave way to dependence on processes and systems. Innovations augmenting or replacing intuitive experts improved consistency, increased prediction, and lowered costs. And multiple innovations disrupted existing systems competing on the basis of simplicity, affordability, and accessibility (Christensen, 2009 p.6). An example of a highly successful process innovation is Henry Ford's assembly line, which made automobiles available to mass markets. Development of an industry is highly reliant upon business models and value networks. Clayton Christensen (2009, pp. 9, 180) describes both. A *business model* consists of the following components:

1. *Value proposition:* product or service that helps customers do jobs they want to get done

2. *Resources*: people, property, equipment, facilities, technologies required to deliver value propositions to customers
3. *Processes*: habitual ways of completing repeatable tasks successfully
4. *Profit Formula*: Required revenue and margins to deliver the value proposition

A *value network* is the context of a business model, linking suppliers, customers, and channels to satisfy customer needs. Industrial transformation cannot occur through technology alone. Technology innovations must be framed in business models and value networks. Christensen makes a distinction between two types of innovations: sustaining and disrupting. Advances that drive performance improvement as measured by historic customer perspectives of value are sustaining innovations. They help market-leading organizations continue to improve their products and services to their best customers. But the people and institutions that benefit most from sustaining innovations are market leaders because sustaining innovations support existing business models and value networks. Disruptive innovations are often less capable than their sustaining counterparts in delivering features and functions, but they are simpler and more affordable. When they enter an industry, they are not sufficiently robust to appeal to the main customer base, but they attract a group of new customers who are either over-served by the offerings of market leaders or cannot afford products and services of leading companies. A simplified Christensen disruptive innovation model is shown in Figure 1 (Christensen, 2009, pp.4-7).

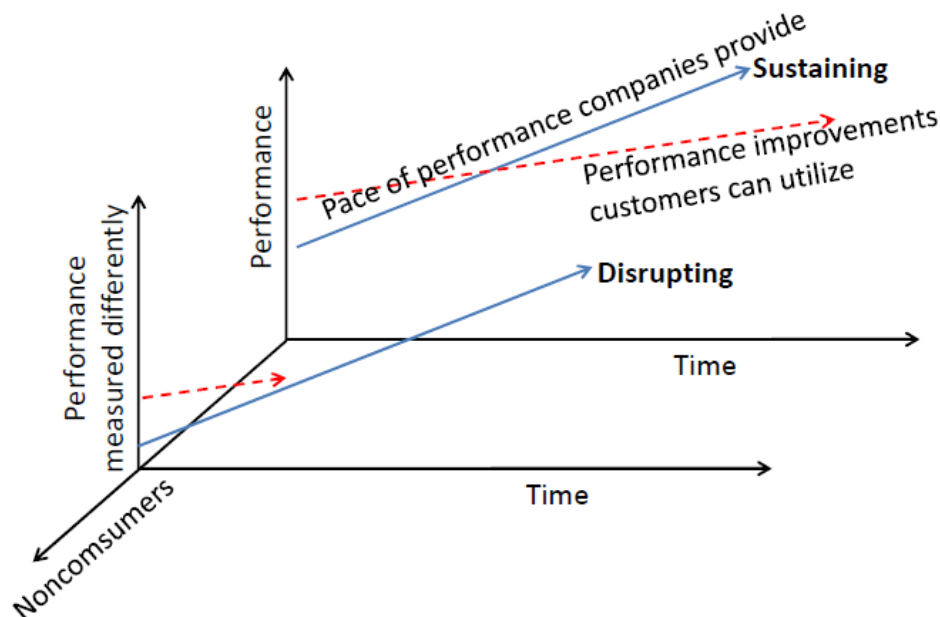


Figure 1 Simplified Christensen Disruption Model

Performance of products or services is plotted on the vertical axis and time on the horizontal axis. The non-consumers axis in the third dimension permits different customer planes for sustaining and disrupting innovations. The sustaining section of the chart contains the main customer base while the disrupting portion includes new customers who were either non-consumers or over-served former consumers of products and services offered by market leading companies. An important contention of the model is that companies can provide performance at a faster rate than customers can use. In other words, there is a time lag between the availability of performance features and the ability of customers to use improved performance features to their advantage. The simplified model does not show the multiple customer segments and distribution curves of the full model, but the concepts are clear: performance outpaces the understanding of how to use it, and disrupting innovations provide less performance than market leading products and services, but they apply to a different set of customers with different business models and value networks. The performance pace of disrupting products and services also increases at a faster rate than performance utilization. If performance in the disrupting plane is capable of satisfying the needs of the main customer base of the sustaining plane, the entire industry changes.

Movement from Intuition to Precision

When industries first emerge they are highly dependent upon intuitive experts who operate on heuristic rules based upon their experience and training to solve problems that are either completely unknown or ill-defined. These experts are always in short supply and are highly compensated. Intuitive experts drive investigations into the systems and components of the problems they confront. With time, intuition is replaced with process understanding. As more is understood about systems involved in these industries, processes are created to deal with challenges regularly confronted in activates needed for the effective system operation. The movement from intuition to process understanding is always dependent upon the recognition of systemic relationships and component interactions. Often, specialized equipment is needed to reveal operational systems. Microscopes are needed to understand bacteria, and computer assisted laboratories gradually open understanding of genetics. In the words of Herbert Simon (1966, p. 27): “Leeuwenhoek and his microscope, Galileo and his telescope, Lawrence and his cyclotron, and so on. God is on the side of the highest resolution”. When systems are sufficiently understood to achieve a desirable outcome, effective problem-solving measures can be incorporated into processes, and dependence upon intuitive experts is greatly reduced.

Hospital Business Models

Hospital business models were created when medical practice was considered an intuitive process only accessible to highly trained experts. They have evolved to include many standard processes resulting from complete (or nearly complete) understanding of groups of illnesses and therapies. Those standard processes add value to patients in two important ways:

1. Products and systems can be reliably applied to effect cures
2. Precise measurements can be defined and tracked so continuous improvement in effectiveness and efficiency becomes possible.

But the commingling of both standard processes and intuitive treatments creates an unwieldy organization. Christensen (2009, p.75) describes the hospital business model:

The organizational paradigm of the general hospital coalesced in an age of intuitive medicine. The entire hospital was essentially a solution shop. But today’s hospitals are substantially different. As technological and scientific progress enabled standardized processes and treatments for precisely diagnosed disorders, hospitals commingled value-adding process and solution shop activities within the same institution – resulting in some of the most managerially intractable institutions in the annals of capitalism.

The “solution shop” is a business model that supports the work of intuitive experts. It is structured to diagnose and recommend solutions to unstructured problems. Solutions shops almost always charge clients on a fee-for-service basis (Christensen, 2009, pp. 20-21). A value-adding business process (VAP) transforms inputs of resources – people, materials, equipment, information, and capital – into outputs of higher value. Value-adding businesses generally bill customers for results (Christensen, 2009, p.22-23). In many cases, the advantages of precise measurements and quality improvement are difficult to administer in hospital environments because solution shop cost and billing models are applied even when value-adding activities are involved. Kaplan and Porter (2011, p.4) claim that “there is almost complete lack of understanding of how much it costs to deliver patient care.” They contend that the inability of the health care system to properly measure and compare costs with outcomes has significantly impeded effective health care reimbursement approaches. And they estimate as much as 36 percent savings by making patients and their conditions the fundamental unit of analysis for measuring costs (Kaplan, 2011). Value-added models are needed to use patients and their conditions to define measurements and determine costs rather than simply relying on services rendered. There is a great deal of work involved in precisely defining the activities and interfaces involved in medical VAPs. Kaplan (2011, p.9) recommends seven steps to create a cost measurement system:

1. Select the medical condition and/or patient population to be examined.
2. Define the care delivery value chain.
3. Develop process maps of each activity in patient care delivery; identify the resources involved and any supplies used for the patient at each process.
4. Obtain time estimates for each process step.
5. Estimate the cost of supplying each patient care resource.

6. Estimate the practical capacity of each resource provider, and calculate the capacity cost rate.
7. Compute the total costs over each patient's life cycle.

If hospitals can continue to collect revenue sufficient to satisfy their governing boards through fees for services, there is little incentive to engage in the hard work needed to define VAPs. Adding to the challenge is the fact that one organization may not control all the components contained in the diagnostic and treatment system, which much be modeled from an integrated perspective even if it is delivered in modular stages. Companies cannot optimize systems they do not own. With ownership and authority spread among many groups, even the creation of treatment process maps can be problematic.

With continued pressure to make health care more accessible and affordable there are two clear paths for health care disruption following the Christensen Model of Figure 1:

1. clinical method of patient care
2. venue of diagnosis and treatment

Clinical Method of Patient Care

With extraordinarily high patient to physician ratios and substantial costs associated with physician time, it is possible to apply the historic elements of market disruption to clinical practice -- simplicity, affordability, and accessibility. With well-defined VAPs, the highly expert intuitive skills of physicians would not be required to treat precisely defined illnesses. Medical judgment could not be completely removed from the treatment process without unacceptable risk, but the judgment of physician assistants and nurse practitioners could adequately manage standard therapies, and consult with more highly trained physicians when needed. An added benefit of patient interaction with less expensive medical professionals is the potential of more time with patients. The medical system is treating people, not just blood tests, X-rays, or ultrasound images. Kriel (2000) is critical of medical systems that rely too much on equipment and tests and not enough on relationships between patients and health care providers. Physician assistants and nurse practitioners fit best into VAP business models. Adding an additional business model, facilitated networks, to the VAP model offers potentially more benefit to patients through information network sharing among health care professionals.

Diagnostic and Treatment Venues

Hospitals are complex organizations capable of dealing with the most esoteric of health problems, but they are not organized to deliver standard therapies efficiently and effectively. Venues capable of disrupting hospitals include clinics, physician's offices, and perhaps even patient homes eventually. Technologies are available now that make all of these venues viable, although we have not yet established how to take advantage of those technologies. In addition to the need for solid VAP business models, key factors in implementation include appropriate risk management and well defined and managed processes.

Political Challenges

One reason health care is so hard to reform is that there are many powerful players influencing the industry. Politicians, physicians, lawyers, corporations, and insurers care about the way health care is designed and implemented, and they are likely to oppose changes that they believe will negatively affect their interests. We can expect that hospitals will fight disruptive models that threaten to take away profitable business from their solution shop cost and billing practices, since changes in clinical practice and treatment venues will quickly affect a portion of their main customer base. A favorable political and legal climate can promote disruptive practices and support people and organizations pushing for change. Tort reform is a particularly sticky area, since doctors and politicians often point to defensive medicine as a significant contributor to overall health care costs (Searcey, 2009). It is hard to see how the political will needed for change can emerge in the emotionally charged and highly partisan legislature that exists at the current time in our nation's capital.

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